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U. S. MANUFACTURED METAL EXPORTS, in the calendar year 1900, will aggregate $200,000,000 in value, says the U. S. Bureau of Statistics. Steel rail exports will amount to $12,000,000, and iron and steel manufactures, for the ten months ending Nov. 1, aggregated more than $100,000,000. In 1890 the value of steel rails exported was only $315,000; in 1896 it was was $540,000; in 1897, $2,500,000; in 1898, $4,500,000; in 1899, $5,250,000. Of the rails exported nearly $1,000,000 worth went to Europe, $1,000,000 to Mexico, $2,000,000 to South America, $4,000,000 to British North America, and $2,000,000 worth to Asia and Oceanica. About $5,000,000 of American locomotives went with the rails, and with these about $3,000,000 worth of American cars. The value of agricultural implements exported has increased from $3,859,184 in 1890 to $16,094,886 in the fiscal year 1900. Pig iron exports in 1890 amounted to 18,458 tons, valued at $300,832; in 1900 160,690 tons were exported, worth $3,124,853. In 1900 the bar iron exports amounted to 18,457,435 lbs.; wire exports, 236,872,806 lbs.; nails, 113,862,461 lbs. The total iron and steel exports for the calendar year 1900 will reach $140,000,000 in value, as compared with $25,542,208 in 1890.

U. S. COPPER EXPORTS for 1900 were valued at $57,851,707, with the probability that the exports for the calendar year 1900 will exceed $60,000,000. In 1890 the copper exported was valued at only $2,349,392; and while the manufactures of brass exported in 1890 were worth only $467,313, those for the calendar year 1900 will aggregate fully $2,000,000 in value.

ALASKAN COPPER DEPOSITS are reported upon by B. F. Millard, of Chippawa Falls, Wis., who has been in the copper country of Alaska since 1898. According to his story, the copper mines in the Copper River region, will exceed in output any yet discovered in the world. Near Chittyna, he says, he found extensive veins of copper yielding 85% of ore; and this vein has been located for 5 miles in length and to a depth of 160 ft.; he estimates that if worked to a depth of 100 ft. only it would yield $780,000,000 at the present price of copper. He found other deposits averaging 68% and 40% down to 13%. As the Calumet & Hecla ores only figure at 3½ to 4½%, and the mines are some thousands of feet deep, these estimates for Alaska seems incredibly large.

AMERICAN BRIDGES IN AFRICA still worry the English manufacturers. The "Iron and Coal Trades Review," of London, of Dec. 5, says that the American Bridge Co. has secured the contracts for building 34 bridges on the Uganda Railway, requiring about 8,000 tons of steel. They bid against all the principal British bridge manufacturers.

LONDON RAPID TRANSIT PLANS are multiplying and practically all include underground electric lines. The Yerkes syndicate is said to have about completed a contract with Price, Reeves & Co., of Westminster, to build the Hampstead Underground Electric Railway for $20,000,000. The most important other line proposed is a railway between Waterloo Station and Baker Street, across the city, and having branches to Paddington Station, and to the Elephant and Castle, to the south. This line would have to tunnel under the Thames. Extensions are now in progress on the Central London Underground, and the South London Electric Railway is under construction from Finsbury Park to the city, and will be completed in about a year. It is said that American capitalists are promoting an underground electric road to connect Putney and the West End of London. The Central London line is asking Parliament for permission to extend its line from the Bank to Liverpool Station.

THE SAN LUIS-SANTA CLARA RAILWAY, in Cuba, would be about 335 miles long and could be built in 1½ years, says Sir William Van Horne, who represents the syndicate expecting to construct it. They propose to acquire a strip of land 40 m., or about 131 ft. wide, for this purpose and estimate that 5,000 workmen could be employed. There will be no heavy grade and no tunnels. This line would connect Santiago with the west end of the island and open up an exceedingly fertile section of the island that now badly needs transportation.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred on the Southern Pacific Ry. near Fenelon, Nev., on Dec. 11. A helper engine collided head on with a double header extra freight, which it had been sent to assist, resulting in the deaths of two men and the serious injury of five others.

THE VITAL STATISTICS OF HAVANA, CUBA, have been officially published by Major and Surgeon W. C. Gorgas, Chief Sanitary Officer of Havana. As so much has been said recently about yellow fever in Havana, taken in connection with the cleansing of the city by the American forces, some abstract of this report is interesting. In the first place, the death rate for November, 1900, was 21.31, or smaller than for any other November in ten years past. This rate compares favorably with 23.09 for Munich, 25.02 for St. Petersburg, 30.08 for Dublin, and with similar figures from other large cities in Europe. The population of Havana in 1899 was 242,055, and since then emigrants enough have arrived to swell this number to at least 250,000. While the number of yellow fever cases—214—is large for November, it is one-third less than in October, and is much below the average for the last ten years. In 1896 there were 1,282 deaths from this cause, 858 in 1897, 553 in 1895, 496 in 1893 and over 300 deaths in 1890, 1891, 1892 and 1894. In 1898, however, the deaths amounted to only 136, and 103 in 1899; from Jan. 1 to Nov. 30, 1900, the deaths from this cause were 290, and this rise in fatality has caused the outcry. From Jan. 1 to Nov. 30, 1900, 1,145 cases occurred in 847 houses of the city out of 26,701 houses, or in 402 blocks out of the 857 occupied blocks forming the city. As showing the effectiveness of disinfecting the 847 houses, a second case did not appear in 668 of these houses; and while a second case did occur in 122 houses, after they had been a second time disinfected no third case occurred in 790 houses out of the 847. Major Gorgas says that he sees a marked and steady improvement in the general condition of the city as to cleanliness, and the system of inspection and fines among the houses of the poorer classes has a better effect than having these houses cleaned by our own men. It teaches the people to do their own cleaning. One remarkable feature of this year's epidemic was that yellow fever cases occurred to an unusual extent in the more modern and better built portions of the city, and considerably removed from what were formerly considered the centers of this disease.

THE MUNICIPAL OWNERSHIP OF WATER-WORKS, especially that of London, formed the chief subject of the late presidential address of Mr. James Mansergh before the Institution of Civil Engineers. He pointed out that of 15 great cities in the world London alone was controlled by private companies in the matter of water supply. In discussing methods for the transfer of London's supply to public control, he said that in the Stockton water supply case the Parliament committee recommended their purchase by the payment of full statutory dividends in perpetuity; or, a capital payment equal to the aggregate of these dividends for 25 years. But as the result of an arbitration the company actually received the equivalent of a 26¼ years' net income.

A STEEL DAM is now being built at a point about 12 miles from Houghton, Mich., which is very similar to the Ash Fork dam in Arizona, described and illustrated in our issue of May 12, 1898. It has a concrete base, 64 ft. long, and 14 to 25 ft. thick. Upon this are steel bents or A-frames, 8 ft. apart, between which are concave steel plates, forming the face of the dam. The steel work is about 472 ft. long, with a maximum height of 74 ft. The bulk of the concrete (about 8,000 cu. yds.) is in place, and the erection of the steel work has been commenced at the ends of the dam. The work is figured for stability against overturning, sliding, etc., in the same way as a masonry dam. It is being built by the Wisconsin Bridge & Iron Co., of Milwaukee, Wis., who also built the Ash Fork dam, and we are indebted to Mr. J. F. Jackson, engineer for the company, for the above particulars.

STAYBOLTS FROM SECTIONS OF WIRE ROPE are being used on the Intercolonial Ry., of Canada. These staybolts are made after a method devised by Mr. G. R. Joughins, Mechanical Superintendent of the road, and described in a recent issue of the "Railway and Engineering Review." To make a bolt of 1 in. in diameter a piece of ⅞-in. round iron of a suitable length is taken and a ferrule is placed upon it at each end. Around both iron and ferrules a bundle of wires, each about ⅛-in. in diameter is placed and then over the wires at each end is put another ferrule, and then the parts composing each end are welded together, thus forming a solid knob, which can be machined down to the proper size and threaded. Another way is to have a rope or strands made up with a large core of metal. Then by cutting off pieces of suitable length and electrically welding them on to suitable pieces of metal, either before or after application to the plates, a practicable staybolt is quickly produced.

THE HIGH-SPEED ENGINE with valves moved by hydraulic pressure, which was exhibited at the Paris Exposition by the French firm of Schneider & Co. and described in Engineering News of Aug. 16, p. 107, proved a total failure. As was predicted in that article, the difficulties inherent in such a system of operating rapidly moving valves proved insurmountable, and while the engine was at last made to turn over after weeks of tinkering and adjusting, it could only run very slowly, and was so manifestly a failure that the attempt to show it under steam was finally abandoned.

THE STEAMER "VADERLAND," of the International Navigation Co., which is due at New York on her maiden voyage, is the first of four new steamers which this company is building for the New York-Antwerp line. She is 580 ft. long, with a tonnage of 12,000 tons and a freight capacity of 11,000 tons. She will carry 342 first-class, 194 second-class, and about 1,000 third-class passengers. The "Vaderland" was built by John Brown & Co., Clydebank, Glasgow, and the "Zeeland," a sister ship, is to be launched from the same yard in a few months. The other two ships of like dimensions, the "Finland" and "Kronland," are building at Cramps yard in Philadelphia, and are to be finished early in 1901.

ARCTIC EXPLORATION IN 1901 is to be undertaken by a number of nations. On the part of the United States Peary is now in the north of Greenland, pushing toward the Pole; and Mr. E. B. Baldwin, representing Mr. Wm. Ziegler, of New York, is now in London inspecting ships and preparing for an expedition north by way of Franz Joseph Land. Vice-Admiral Makaroff, of the Russian Navy, is fitting out the Russian ice-breaker "Ermack" at Newcastle for a trial on somewhat the same route. The Duke of Abruzzi, who took the "Stella Polare" within 241 miles of the Pole and 23 miles nearer than Nansen, will join with the latter in another attempt by the same route, also by way of Franz Joseph Land. The Germans are planning an expedition, but have given out no plans; and Sverdrup, a Swede, and Stein, a German-American, were lately in Ellsmere Land. Capt. Dernier, a Canadian, proposes to seek the Pole, and is organizing his party. The Baldwin expedition is backed by any necessary sum of money, and is expected to get away next summer. The ice-breaker "Ermack" is well fitted for the work, so far as ice-breaking and hull resistance are concerned, but her success will depend largely on the time consumed and her coal-carrying capacity.

GREAT BEAR LAKE, in British North America, has been surveyed this year by Mr. J. M. Bell, of the Canadian Geological Survey. Mr. Bell reached lat. 68°, or 2° beyond the Arctic Circle. He says the shores of this lake are rather arctic in appearance, but that spruce timber is found as far as the northeastern extremity of the lake.

A VANCOUVER-AUSTRALIA TLEGRAPH CABLE is to be laid by the end of 1902 by the Telegraph Construction and Maintenance Co., at an estimated cost of $8,975,000. The route from Vancouver is by way of Fanning Island and the Fijii Islands to Queensland and New Zealand. The joint committee of the British and Australian governments formally accepted the tender of the above company, at Melbourne, on Dec. 3.

THE 20TH CENTURY BEGINS on Tuesday, Jan. 1, 1901, in the Pacific Ocean just East of the Friendly Islands, says John Ritchie, Jr., in an item printed in the "Ladies' Home Journal," and reprinted, with other matter by the Dixon Crucible Co., of Jersey City, N. J., for circulation. He goes on to explain that the theoretical line marking 180° east and west of Greenwich has two jogs in it, put there by the agency of man in the arrangement of business affairs. The Russians brought eastward the day of St. Petersburg and established it in Alaska. But when the United States came into possession of that country the authorities deemed it wise to have one day throughout the United States; and so the date-line was set 10° to the west of the actual meridian so as to include in our day the outermost island of Attu. For this reason Attu, in 170° East Long., is the latest place on the earth to retain any certain day. In the same manner certain groups of islands in the Southern Pacific have been included in the day of Australia and New Zealand, with which they have business relations, although some of them lie east of the 180th meridian.

BOILER EXPLOSION AT THE POWER HOUSE OF THE CHICAGO & NORTHWESTERN RY.

In our issue of Dec. 13 we described the serious results of the explosion of a shell boiler of 125 HP. at the power station of the Chicago & Northwestern Ry. at its Wells St. terminal station, Chicago. The accompanying photograph represents the destruction wrought by the explosion. At the coroner's inquest some of the firemen stated that about a year ago the boiler pressure had been reduced from 100 lbs. to 90 lbs., and also that the boilers were heavily worked, but on the other hand we have information to the effect that ordinarily only three boilers were in service, the fourth being used during the early part of the evening when there is the greatest demand for power. The inquiry has been postponed until the chief engineer in charge of the power house has sufficiently recovered to be able to attend. Three of the persons injured by the explosion have since died, making eight deaths in all.

POWER-HOUSE AT WELLS ST. STATION OF CHICAGO & NORTHWESTERN R. R., CHICAGO, ILL., WRECKED BY BOILER EXPLOSION, DEC. 3.

The view reproduced was taken from the street, on the side of the building, opposite the tracks, and shows the complete wreckage of the structure. Work was very soon started in erecting wooden partitions to enclose the least injured corner of the building. Boilers for temporary service were also ordered, and meanwhile steam was supplied from a locomotive stationed on the sidetrack in front of the building. A line of steam hose was run from the engine to the pipes of the steam heating system, and in 24 hours the railway company had an engine and dynamo at work.

PAPERS READ AT THE ANNUAL MEETING OF THE ENGINE BUILDERS' ASSOCIATION.

A brief report of the first meeting of the above Association, held in New York on Dec. 4, was published in our issue of Dec. 6. The Association is now composed of 14 prominent builders of high-speed automatic steam engines. At the meeting it was decided not to give out the papers read before the meeting for publication, but to furnish to the technical press official abstracts of these papers prepared by the Secretary of the Association, Mr. S. F. Bogg. These official abstracts are printed below, as follows:

CO-OPERATION BETWEEN ENGINE AND GENERATOR BUILDERS IN CONNECTION WITH ENGINE-TYPE UNITS FOR POWER PURPOSES.

By H. C. Ebert.*

It is proposed in this paper to deal specifically with the subject of so-called engine-type electric generating sets. The manifold advantages of the engine-type direct-connected generator unit for power, traction and lighting purposes over the old style high-speed belted type are so apparent to all that I think they need not receive consideration here. The management of the Westinghouse Electric & Manufacturing Co., is glad of the opportunity to place before this association some of the points which in its opinion might advantageously be considered jointly by the engine and the generator builders with the object of establishing, if possible, a uniform practice in treating the complex conditions which arise in getting the two parts of an engine-type unit successfully installed. We have observed that when the consulting, mechanical or electrical engineer specifies the size and type of the generator unit to be furnished he generally designates an engine that in capacity, speed and regulation will closely correspond with the same characteristics of the generator to be provided; but when the selection of an engine to drive a certain size generator is made by the purchaser, or he is coached in his selection by the ordinary generator or engine salesman (and this is oftener the case than one would generally suppose), an engine is invariably secured which in these three most important features does not match the electrical part of the outfit. It is in these latter cases where eventually the engine builders have their difficulties and we, also, have ours, for the engine and generator are correctly considered by the purchaser as a single unit, and the failure of one part to meet his requirements constitutes, from his own standpoint and that of his engineer, sufficient ground for withholding his acceptance and purchase of any part of the unit. Manifestly, this is a hardship to the manufacturer whose apparatus is in all respects what it should be and as represented. Our object and yours should be to minimize the chances of an improper combination of engine and generator, and to this end we will invite correspondence from the engine builders and give close attention in the appropriate departments of our works to any inquiries they may make respecting the electrical or mechanical details of the generator set to be provided, so that perfect calculations may be made for efficiently driving the generator, from which ultimate power is to be derived.

The engine and generator specifications must be analogous in so far as capacity, speed and regulation are concerned. It is the general practice of the dynamo builders to give their machines a normal rating, allowing for 25, 50 or 75% overload for certain periods, ranging from ten minutes to two hours and sometimes longer. This overload capacity upon which the electric companies' salesmen lay considerable stress avails the purchaser nothing if the steam end of the unit is inadequate to care for it.

There should be uniformity in rating engines with regard to overload capacity of the generator to be driven. Of course, steam pressures, belting, etc., operate to change the engine capacity, but it would seem there could be greater uniformity than has yet been shown.

The engines for direct or continuous current power work should be designed to regulate quickly for sudden changes in the load and the drop in speed from no load to the maximum load should be as nearly a straight line as possible. This is absolutely necessary to properly care for the overcompounding of the generator as the load increases.

It should be noted that what would be considered ideal regulation and operation in a direct-current installation would not be satisfactory with alternating-current power generators. There is no difficulty whatever in running two or more direct-current generators together on the same circuit and dividing the loads equally and maintaining them practically constant on the different machines. However, in running alternators together, particularly at slow or medium speeds, the problem is different. In order that each alternating-current machine shall deliver its proper share of current for the common circuit, the machines must work harmoniously and synchronously. The fundamental requisite is that the E. M. F.'s or voltages produced by the two or more machines operating in parallel must be equal at all times. If not, then at any instant when the voltage of one machine is lower than that of the others a current will be sent through it from the other machines, this of course not being desirable.

If the engine governors tend to give different speeds, say 500 and 525 revolutions respectively, then it is evident that when the two alternating-current machines are in parallel, the machine which tends to run at the higher speed will carry all the load until the speed is reduced to 500 revolutions, when the second machine will begin to carry load.

It is essential that the governing of the speeds of the alternating current machines shall be such that when running at a common speed they shall receive their proper amount of power. As stated heretofore, it is to be observed that engines which govern closely between no load and full load, may not be as well adapted for running alternating-current generators in multiple as other engines in which the regulation is not so close. For example, if one engine runs at no load at 100 revolutions, and drops off 1% at full load, and a second engine also drops 1% between no load and full load, but happens to run at a slightly higher speed, say 101 revolutions at no load and 100 revolutions at full load, then it is evident that one engine would carry its full load before the other engine had begun to carry any load. If, on the other hand, the engines drop 5% in speed; that is, from 100 to 95 and from 101 to 96 revolutions respectively, then a comparatively small load will reduce the speed of the latter to 100, so that the engines will begin to work together almost instantly the generators are thrown in parallel, the engine which tends to run faster carrying only a slight excess load.

A member of this association suggested that this paper should contain something to bring about a discussion of what the engine builders should do and what not, and the best way to avoid disputes and disagreements, presumably between the purchaser, the engine contractor and themselves. There would seem to be no good reason for dissension or disagreement if the engine company furnishing the engine and the electrical company furnishing the generator will acquaint each other with the general terms of their contract with the purchaser in so far as those terms relate to the integral parts of the generator and engine combination to be supplied. In taking up correspondence with this object in view we will at once disclose any discrepancy in what we are to furnish conjointly to make a complete unit. Usually the parts which are not clearly covered in either the engine company's or the electric company's agreement are of a minor and inexpensive character, but still if no attention or thought is given to them, we find ourselves on the ground with a shortage that will seriously retard the erection work and greatly increase its cost. Up to and including 125-K-W. engine-type generator, 200 revs. per min., we furnish simply the bare machine; that is, the fields and armature without shaft, shaft key, outboard bearings, bed-plate, steel guide strip or holding down bolts. When we contract for the entire unit our order to the engine company clearly stipulates that the parts just enumerated are not a portion of the generator, and are to be included with the engine. With machines of larger capacity than 125 K-W. we supply bed-plate, steel guide strip and holding-down bolts, as usually the larger sizes cannot have a common subbase with the engine. These remarks so far, excepting where they relate to parallel running of alternating-current generators, treat especially of continuous current 125, 250 or 550-volt generators. The conditions surrounding the combined alternating-current engine type unit for power purposes are somewhat different and will be referred to later on.

It is assumed that all the members of the Engine Builders' Association are familiar with the work that the committees on "Standards for Direct-Connected Generating Sets," appointed by the American Society of Mechanical Engineers, and the American Institute of Electrical Engineers, have thus far accomplished in the direction of standardization, and it is confidently anticipated that their final reports will lead to some definite and unanimous action along that line. The time has certainly come when steps should be taken to prevent unreasonable requirements, and this standardizing of sizes, speeds, shaft diameters and general dimensions, if strictly adhered to, will undoubtedly be a strong preventative measure. The report of the committee already published, which was I believe but tentative, recommended capacities, speeds and probable shaft sizes for center and side-crank types of engines from 25 to 250 K-W. capacity and generators inclusive. It made no definite comments on the subject of armature-spider bore, press fits and the method of keying to shafts. In connection with these questions, I would like to outline here briefly the Westinghouse Electric & Manufacturing Co.'s standard practice, with which

*Of the Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

we have invariably had success. Armature spiders are arranged to receive a shaft amply large for extreme rigidity so as to eliminate crank action as far as possible, it being absolutely necessary that the armature run perfectly central in the fields to prevent unbalanced magnetic pulls. Shafts are figured for both deflection and fiber stress, taking into account the possible unbalanced magnetic pull. In submitting generator drawings to engine builders we call attention to this magnetic action if the armature becomes decentralized, and state on the drawings the amount of magnetic pull which may be expected on the generator. As this unbalanced magnetic pull acts at right angles to the shaft and may be in any direction in the plane of revolution, it should be carefully considered, not only for the shaft diameter, but also for strength of foundation, sub-base and bearing housings. The connection between the outboard bearings and the sub-base should be perfectly rigid. One or two instances wherein this magnetic action was not taken into consideration by the engine contractor finally resulted in almost total destruction of both engines and generators.

We make allowance for a press fit in the armature, the amount depending largely on the material, or rather the quality of the material in the spider. This is such that the fiber stress per square inch produced by forcing the hub on the shaft is greater than the fiber stress produced by centrifugal force due to the rotation of the armature at maximum running speed. The engine shaft and gages should be absolute, as a matter of record. It is a simple thing to use pin gages and they are better for giving close results. We therefore supply exact shaft gages to the engine builder as soon as the shaft diameter is settled. Two short press fits are employed, one at each end of the spider hub. It is our practice to use only a single feather or parallel key, half in the shaft and half in the hub. This key is furnished by the engine builder and fitted tightly to the shaft sidewise. Between the top of the key and the bottom of hub keyway, there is a clearance of about 1-32-in. The feather key admits of easily centering the armature, acts as a guide in pressing it to position and does not deform the hub as a driving or tapering key tends to do. We supply key gages at the time shaft gages are sent to the engine maker.

The foregoing remarks relative to standardizing apply simply to direct-current generators. With respect to alternating-current engine-type machines the case is not so simple. There is not the same demand for uniform standards of alternating-current dynamos, there being fewer builders of this type of apparatus. Usually, also, the generators are of such large size that it is not a requirement to have everything in accordance with a predetermined standard. It would be difficult to even assign standard limiting dimensions, since there are usually two types of construction, one in which the field may be removed at right angles to the shaft, and the other in which it may be removed parallel to the shaft; this, of course, requiring different engine arrangements, especially in regard to shaft lengths. Consequently, to properly combine an engine-type alternating-current unit, even of the smaller capacities, the drawings should be taken up in each case and the necessary arrangements made for a successful combination.

In general, I would add that the Westinghouse engine-type generators for both alternating and direct-current power work can be designed with any one of the following characteristics:

1. The generator revolving element may be pressed and keyed on to an extension of the engine shaft; the engine builder furnishing the shaft, shaft keys and outboard bearings.

2. The generator may be self-contained and include the shaft, shaft keys, outboard bearing and a half coupling flanged for directly connecting to the engine shaft or flywheel.

3. The generator revolving parts may be designed with a flanged extension for directly connecting to the flywheel. The shaft on which this revolving element is pressed and keyed may or may not be a part of the engine shaft.

4. The large machines, 850 K-W. and above, can be built with bosses on the spider arms for directly connecting to an extension on the engine flywheel. In either of these cases the Westinghouse Co. will provide the necessary gages and templates to enable the engine manufacturer to arrange his parts for connecting to the generator.

SOME OF THE REQUISITES OF MODERN LIGHTING GENERATOR SETS.

By H. G. Reist.*

It will not be possible to fix absolute speeds for engines used for directly driving alternating-current machines because currents of various frequencies are used for different classes of work, and dynamos must be built with an even number of poles or, better yet, with a number of poles that is divisible by four. The ordinary frequencies used in this country are 25, 40 and 60 cycles per second, but in Europe the usual frequency is 50 cycles. To illustrate the variation in speed necessary for the various frequencies for 60 and 40 cycles, a speed of 200 revs. per min. may be used, but for 25 cycles the speed should be 187 or 214. Similarly we can make 60 and 40-cycle dynamos to operate at 100 revs. per min., but the 25-cycle machines must be driven at 94 or at 107. In working over a list of speeds for the various frequencies it will be found that a mean speed may be selected which in no case need be much departed from, so that it seems perfectly practicable to select a range of speeds for the various sizes of engines at which they may be run without any changes except an adjustment of the governor. Then by a careful selection of sizes, best ranged in geometrical progression, it will be feasible to keep down the number of machines very greatly, thus leading to the practicability of making special tools for more of the parts and also to carrying parts in stock and helping toward quick deliveries.

We have given considerable thought to the selection of a range of sizes and have come to the conclusion that if the units were so spaced that each one has a 50% increase over the one below it, there will be a sufficiently large number of machines to meet all ordinary conditions. This conclusion has also been sustained by having had practical application in lines of generators and motors spaced in about this way; it is rarely that it becomes necessary to go to the expense of developing anything between. This method of determining sizes necessarily gives some of the machines on the list odd ratings, but this will occur in any case many times with either the engine or the generator, since one is rated in horse-power and the other in kilowatts.

The variation in speed given in some tables which we have prepared allows the same engine to drive generators for the three frequencies standard in this country. With very few exceptions the total variation in speed is less than 10%, in most cases being not more than 2½% from the mean speed. For each capacity given, except the smaller ones, several speeds are proposed to accommodate the different types of engine.

In all reciprocating engines there is an intermittent speed, the speed gradually increasing during the stroke until such time that the power applied is less than the mean power absorbed, after which the speed gradually decreases until steam is again admitted. It will thus be seen that in every single-crank engine there is during each stroke or each half revolution a period of increasing speed and one of decreasing speed. With two cranks at 90° there will be four such periods during each half turn. With cranks set 120° apart there will, of course, be six such periods. The amount of fluctuation in speed is dependent on the number of cranks, the weight of the reciprocating parts, the length of the connecting rod, the proportion and adjustment of the valves and the weight of the flywheels. It is desirable to keep this variation within certain limits for the parallel operation of the generators, but more particularly to insure the satisfactory operation of synchronous apparatus, such as synchronous motors and rotary converters, from such circuits.

When two generators are running in multiple, their mean speed will be the same, but the speed is variable as already explained, there is an instant during which one generator runs a little faster than the other. It will be seen that its potential wave will then get ahead of the wave produced by the other machine and in consequence current will flow into the second machine and tend to drive it as a motor. A little later, when the engines are further along in the revolution, these conditions will be reversed. This produces cross currents between the machines, which should be avoided. It might be prevented with duplicate sets, if the engines were synchronized; that is, if they were run with the cranks of the machines in the same relative positions. The angular velocity of one engine is then the same as that of the other at all times. But this is not a practicable method of operation. This fluctuation is also liable to make synchronously-driven electrical machinery drop out of step. In practice, the allowable variation is usually given in displacement in degrees of any point on the rotating mass from what it would have if the motion was perfectly uniform, which gives a value that is independent of the number of cranks of the engine. Steam engines intended for directly connecting to dynamos should not have an angular deviation of more than 2½ or 3° of phase; or, dividing the number by one-half of the number of poles of the generator to be driven, we get the allowable angular deviation in degress of the rotating mass. Thus, a 40-pole machine should be driven by an engine whose motion is so uniform that a point on the rotating mass will not vary more than $\frac{2.5}{20}$ or ⅛ of 1° from the position it would have if the motion were perfectly uniform.

In order to obtain this result it is necessary to proportion the flywheel to the other part of the engine, and no general rule can be given. The proportion of the connecting rod is a matter of considerable importance in this connection. (Mr. Reist here submitted data covering the flywheel effect necessary to meet the above degree of regulation and submitted a formula representing a safe figure for well-proportioned engines. Mr. Reist's formula covered 25-cycles, 40-cycle and 60-cycle machines and was varied to apply to horizontal engines as well as vertical and to single cylinder engines as well as compounds.) It would naturally be expected that a three-crank engine with cranks placed 120° apart would require a lighter flywheel than one with two 90° cranks, but in working out the forces of compound three-cylinder engines, it is found that other conditions so far enter into the problem that no appreciable better result is obtained than from a two-crank cross-compound engine.

Every since alternating-current machines have been built parallel operation has been discussed and tried, at first with great caution, but it is at present the usual method of operation of installations, and experience has taught us that any two alternators of the same frequency and potentials will operate in multiple satisfactory, if they are allowed to do so by the prime motors. No trouble is experienced in operating machines in multiple when driven by water wheels. There are also many installations of steam-driven alternators, ofttimes of different types, both belted and direct connected, operating satisfactorily in multiple. The principal trouble experienced in the parallel operation of alternators is due to the variation of the speeds of the machines with reference to each other, producing oscillations in the relative motions of the two alternators. This produces cross currents and variations of the cut-offs of the engines.

In some cases the amplitude of these oscillations is limited in extent, while in others the disturbance is liable to increase with more or less rapidity until the machines drop out of step. In some cases the machines may run in parallel for a considerable period, then by some change of conditions oscillations will begin, throwing the machines out of step in a few seconds. The power to produce these oscillations comes naturally from the steam and is caused by the intermittent action of the engine governors, which in their efforts to adjust themselves to compensate for the speed variation cause a periodic delivery of steam. This delivery of steam by jerks keeps up the oscillation in the same manner as the escapement keeps up the motion of the pendulum of a clock. The frequency of this variation is affected by many conditions aside from the flywheel effect of the rotating mass on the engines, such as the period of the engine impulses, the synchronizing power of the dynamo and probably the flywheel effect of any synchronous machinery driven by the current from the dynamo.

The degree of retardation of the governor required by proper parallel operation must depend upon the combination of these effects and is consequently difficult to predetermine. There are, however, cases where a simple retarding device is not sufficient without seriously affecting the governing of the engine. A special device should be devised to cover a case of this kind. Engines that are directly coupled to alternators that are to be run in parallel should be provided with means by which the speed may be adjusted within a small range without throttling, while the engine is running. Such a device is very useful in bringing the machines together without throwing them into parallel when one machine is loaded and the other is idle, otherwise it is necessary to throttle the steam for the engine without load to bring it to the speed of the loaded machine. This device would also be very useful for dividing the load between the machines, since, however carefully adjusted, high temperatures or some other local condition may throw them slightly out of adjustment.

ECONOMY GUARANTEES OF HIGH-SPEED SIMPLE ENGINES.

By E. J. Armstrong.*

The matter of economy does not always receive consideration. The engine that runs smoothly, noiselessly and regularly will have friends and purchasers whether it uses much or little steam. I have no desire to advocate improvement in economy to the detriment or neglect of other qualities which go to make up successful machines, but I believe that many engine builders have but a very imperfect idea of what their own engines are capable of doing. If the subject were more amenable to mathematical treatment the case would be different, but in spite of the marvelous advancement in science at the end of the century, the exact formula for the economical performance of the steam engine has yet to be written. In view of the fact that the steam used by an engine often costs each year as much as the engine itself, it would seem as if the customer might consider steam economy as of first importance and price second. Yet even a small difference in price or a personal preference will decide a purchase without raising the question of economy at all. A difference of 10% in steam consumption between two engines might easily place the more wasteful one in the position of being too expensive, even as a gift; but there is no doubt that there have been and still are even greater differences than this between engines that are sold on equal terms. It is singular that customers who figure so closely on other matters should be so careless and unbusinesslike in this, or that builders should expect to market engines with no economical record and not even a pedigree. This rather anomalous condition of things will soon be brought to an end; for years there has been an increasing tendency among customers to raise the question of steam consumption and builders of engines must recognize and prepare to meet a demand for definite promise and performance in the matter of economy.

This should be welcomed, not as a hardship but rather as an opportunity. It is necessary to obtain more exact

*Of the General Electric Co., Schenectady, N. Y.

*Of the Ball Engine Co., Erie, Pa.

data concerning the performance of automatic engines, and in making efforts to improve the quality of work turned out the first step is a systematic effort towards finding the defects in that work. The first move in reducing cost is to find out what things are costing, and the way to improve the economy of engines is to test them systematically and to learn their deficiencies.

It is not usually practical to test engines of small size after installation; the expense is disproportionate and the difficulties in the way of obtaining accurate results are great. The liability to error and the impossibility of running preliminary tests make it unsafe to make close guarantees to be demonstrated in this way. The proper place to test an engine is on the shop testing floor. With properly arranged apparatus tests can be made in a short time and at little cost.

It is apparently a simple thing to make duty tests with apparatus of this kind, but the matter is really more complicated than it seems. This method of testing engines cannot fail to impress one with the great difference in accuracy possible, compared with the plan of testing after installation, as must be done with very large engines under any circumstances.

The manner in which different tests check up with each other is to some extent proof of their accuracy, and gives confidence in using the data obtained as a basis for future guarantees. (Mr. Armstrong here presented several duty curves, plotted from tests made in the ordinary course of demonstrating economy guarantees.) The majority of the series of tests shown in these diagrams have been checked by engineers representing the purchasers. In other cases reliance has been placed on the builder to see that his guaranties were fulfilled. The rate of water consumption has been plotted without correction for dry steam, for which, however, a proper allowance was made. These results are not at all exceptional, as is proved by the fact that taey practically duplicate each other. They show what is readily obtainable in regular practice, with fairly tight valves, moderate clearance and other conditions favorable. There are other details which contributed to the result and which have to be learned by practice and can be learned at all only by frequent tests.

The single-valve engine is capable of giving results even better than those shown on the diagrams to the extent of one or perhaps one and one-half pounds per hour. At the same time the results are very much better than the average of high-speed work. As the result of these and other tests I have been able to predict very closely the difference in economy which may be expected from a change in steam pressure, from a change in back pressure, from an increase or decrease in speed. It is possible also to speak with considerable accuracy of the difference in economy between a large and a small engine of the same general design, or of the difference in the same engine when carrying a greater or smaller percentage of its load.

In estimating the steam consumption of an engine of a size or under conditions which have not yet been tested, there are two ways of figuring; one is to determine the losses in the engines separately from the steam accounted for by the card. This method while quite complicated is the more accurate of the two and is sometimes very valuable in working out a close guaranty. The other plan is simply to learn the general effect of the different conditions which affect economy and to use some previous tests as a basis.

The building up of a better reputation for the automatic engine is well worth the attention of its manufacturers. No guaranty of economy should be given unless its fulfillment by actual trial is provided for. Where there is no certainty that a test will be made, there is the temptation to give a lower water rate than would be the case were its fulfillment one of the conditions, especially if accompanied by penalties for failure to meet the terms of contract.

Penalties are usually considered quite onerous by engine builders, but if not provided in the contract, the only penalty is the non-acceptance of the engine; and as this is often impracticable because of lack of time, there is a good chance that the guaranty is not worth anything. Definite penalties at least have the effect of protecting those who really make their guaranties in good faith and with a knowledge of what they can do. There is nothing wrong about it from the purchaser's standpoint. A deficiency in economical performance means a direct and continous loss to him. There is one feature of the situation that is manifestly unfair and calls for remedial action. Better economy costs money. It may not actually cost more to build the high-duty engine than a wasteful one, but it costs a good deal more to learn how and to keep up the standard afterwards. It costs money to tune an engine up to meet a close guaranty, and testing engines is an expensive business at the best. There should certainly be an addition to the price when guaranties are required. All duty guaranties should provide for their fulfillment on the shop-floor test before shipment and should always be considered as an extra, it being optional in all cases with the purchaser to accept the proposal with or without the guaranty. If the guaranty does not mean anything, it should not be made. If it does stand for something, it costs a good deal and is worth to the customer all that he is likely to be asked for it.

40,000-TON CAPACITY ORE DOCK OF THE GREAT NORTHERN RY., AT WEST SUPERIOR, WIS.

(With two-page plate.)

The large iron ore shipping docks of the American Great Lake ports are a class of timber construction of which, it is safe to say, no other country affords a corresponding example. Like the large ore carriers of the Great Lakes fleet and the steel car of 100 tons capacity and upwards, they have developed out of the requirements of shipping annually the 16,000,000 tons output of the Lake Superior iron mines to Chicago and the Ohio lake ports, whence is is distributed to the blast furnaces of Illinois, Ohio and Pennsylvania. Probably the largest of these docks so far constructed is the one completed early this year for the Eastern Minnesota Ry., of the Great Northern system. This dock is located at West Superior, Wis., and has a storage capacity of 40,000 tons of iron ore at one time. In addition to the interest which this dock attracts because of its size, it is an excellent example of timber-work designing for structures of this class; and we give the structural details in full upon our two-page plate this week. These drawings are so complete and clear that beyond a brief statement of the main dimensions, which they do not give, we shall leave them to explain the construction of the dock.

In this connection it may be desirable to note that we have retained the usage of the word dock to mean the timber structure carrying the ore pockets and railway tracks alongside of which the vessel is berthed. Strictly speaking, the word dock means an inclosed water space in which a ship floats while being loaded or unloaded, as the space between two wharves or piers. By extension the word has also come to mean any space or structure in or upon which a ship may be berthed or held for loading, unloading, repairing or safe keeping, such as depositing docks, dry docks and floating docks. Accurately speaking, therefore, the structure which we describe here is an ore pier rather than an ore dock, and we have retained the latter designation only in deference to popular usage.

Briefly stated, the dock is 1,500 ft. long, 63 ft. 4 ins. wide, and 73 ft. high from the surface of the water to the base of the rails of the ore tracks, which run on top. On each side there is a row of ore pockets capable of holding 160 tons of ore each. Each pocket is provided with hinged spout which is lowered to discharge the ore by gravity into the vessels berthed alongside, and which is raised out of harm's way when not in use. The ore trains from the mines discharge their loads into the pockets through the traps between the tracks. These traps, the construction of the ore pockets and of the trestle bents which carry them and the tracks and the arrangement of the pile foundations are clearly shown by the drawings.

Construction was begun on the dock on Jan. 1, 1900, and it was completed ready for operation on May 1. The timber-work was designed and erected by the engineer department of the Great Northern Ry.; the spouts were manufactured by the American Bridge Works, of Chicago, Ill., and Pettibone Mullikin & Co., of Chicago, Ill., furnished the spout hoists. We are indebted to Mr. John F. Stevens, Chief Engineer, Great Northern Ry., for the matter from which this description has been prepared.

ANNUAL CONVENTION OF THE LEAGUE OF AMERICAN MUNICIPALITIES.

The fourth annual convention of the League was held at Charleston, S. C., Dec. 12 to 15. There was a marked discrepancy between the number of names on the registration book and the attendance at the various sessions, the latter rarely exceeding 50 or 60 and sometimes running down to 30 or less, while the total registration was reported as high as 250. Many excellent papers were presented and there was a fair amount of discussion on many of them, although not as much as might have been expected had the papers been printed and distributed in advance.

After the usual preliminaries Mr. Henry V. Johnson, Mayor of Denver, Colo., delivered his presidential address. Among other things Mr. Johnson said:

With the increasing population of our cities and towns the questions here discussed are becoming more and more important. More and more our people are flocking from the country into the city. The time has come when we must not only consider the problems for improving the life of our cities, but we must undertake the other task, also, of inducing and promoting a love for rural life. The overcrowded conditions of our great cities is one of the crying evils of our day. How to induce some of the people to leave the unhealthy atmosphere of the overcrowded tenement house, and take their wives and little ones out into the sunshine, the ozone and clover blooms of the country, is equally but not more important than the question of municipal ownership of natural monopolies. The question of the disposal of garbage and of sewage must be treated as carefully and as earnestly as the more aesthetic subjects of our libraries and our parks. The questions of uniform accounting and uniform legislation, street paving, street cleaning and street sprinkling are as essential to a city's prosperity and comfort as the questions of water, light, heat and transportation. Let us bring to the consideration of these questions a spirit of fairness, a spirit of philanthropy, a spirit of faith and of hope and of charity.

SEWAGE DISPOSAL PROBLEMS.

By M. N. Baker.

The first paper bearing on questions of municipal engineering and sanitation was on "Sewage Disposal Problems," by M. N. Baker, of the editorial staff of this journal. It was a general review of the subject, indicating in which pains was taken to show that all sewage must reach water ultimately, whether treated or not, and that water pollution is a matter of degree, disposal by dilution being admissible where the relative volumes of sewage and water are properly proportioned. The tendency of the day is towards the septic tank and contact filter beds, but it seems that filter beds may be so operated as to give virtually the same anaerobic action as that resulting from the septic tanks. Much further development may be expected before sewage disposal is placed on its final basis.

This paper was supplemented by an admirable presentation of the results obtained with a large experimental septic tank at Pawtucket, R. I., by Mr. Geo. A. Carpenter, City Engineer, as set forth elsewhere in this issue.

A PRACTICAL ILLUSTRATION OF MUNICIPAL OWNERSHIP.

By Thos. C. Perkins, Hartford, Conn.

The author described an electric lighting plant at Wallingford, Conn., a place of about 10,000 inhabitants. Mr. Perkins was the engineer for the plant, which was put in operation on Jan. 1, 1900. The system is alternating current of low frequency, with series enclosed arc lamps for street lighting and with incandescent lamps for commercial use. The steam plant includes two 150-HP. high pressure horizontal boilers, two Corliss engines, one rated at 300 HP. and one at 150 HP., a vertical condenser, and various accessories. There is a 150 and a 75 K-W. dynamo. There are 79 series alternating enclosed arc lamps and three alternating multiple enclosed arc lamps, lighting about eight miles of streets and requiring some 14 miles of wires. About 90% of the commercial lighting is done from a secondary three-wire system of distribution, fed from 300-light transformers and requiring about six miles of wiring. The cost of the whole plant, including land and engineering, was $55,000.

Commercial lighting is furnished from dusk to daylight, but the street lights are on the moonlight-midnight schedule, except that the three multiple lamps burn all and every night. One man acts as superintendent, chief engineer, electrician, bookkeper and collector, besides which there are two engineers, one lineman, "who acts as trimmer and occasionally as fireman during the early part of the evening," and an occasional extra man. The latter man is paid $2 a day, when employed. Otherwise, the regular salary account is $300 per month.

Incandescent commercial lights are furnished at 10 cts. per K-W., or an assumed equivalent of ½-ct. per 16-c. p. hour, either by meter or flat scale, customers depositing the cost of meters, where used. The borough wires to the outside of buildings without charge, if not over 50 ft. from the curb, and makes the first installation of lamps without charge. Up to Nov. 1, 1900, or in the first ten months of services, the equivalent of 4,000 16-c. p. incandescent lamps had been installed. As to the cost of the service Mr. Perkins said:

Under the general laws of the state of Connecticut, relating to municipal electric lighting plants, the municipality is required to raise by taxation and turn over to the electrical department each year a sum equal to the actual cost of maintaining the street lighting system, said cost to include all proper charges, including depreciation at the rate of 5% per year. Consequently it will be seen that the larger the output of the station for commercial lighting the cheaper will become the cost of the street lighting.

As a basis of figuring the cost of producing electricity in this plant and the consequent cost of the street lighting, I have taken the month of October last, which is the last month of which I have complete figures. October is an average month in the year as far as the average number of hours street and commercial lighting is required.

Total output, 68,634 K-W.
Commercial circuits, 61,124 K-W.
Arc circuits, 7,510 K-W.
Number of series arcs, 79.
Number of hours burned in month, 142.
Consumption per lamp hour apparent, 612 K-W.
Number of multiple lamps, 3.
Number of hours burned in month, 403.
K-W. consumption per lamp hour, 520.
Tons of coal used, 82.
Kind of coal, George's Creek, soft.
Cost delivered in power station, $4.40 per ton.
Cubic feet of water used in boilers, 25,629.
Evaporation, average for the month, per pound, of coal, including banking and cleaning fires, 8.85 lbs.

For labor, fuel, repairs and general daily expenses for carrying on business	$784.00
Fire insurance on power station	14.00

Boiler insurance	2.78
Indemnity insurance	15.60
Interest on $55,000 of bonds at 3½%	160.42
Depreciation on cost of power plant, lines and equipment, 5% on $46,000	191.67
Total	$1,168.51

Based solely on the cost of operating this plant without respect to the income received, the cost of producing 1 K.W. of electricity is substantially 1.06 cts.

On this basis the cost of running each series arc lamp per month is | $1.40
And of each multiple arc lamp is | 3.35
Cost of each series arc lamp annually on a basis of October | 16.80
And of each multiple arc lamp is | 40.20

In considering these figures it must be kept in mind that there is a difference between the actual cost of producing street lights with such a plant as I have described above and what it actually cost the borough for the street lights for the month of October.

In my opinion the actual cost should be arrived at by deducting the income from sale of commercial lighting from the expenses of operating the plant for the whole month, which expense should include interest and depreciation charges.

During the month of October the total expenses were $1,169, and the income from commercial lighting was $762, the difference being $407. This was the sum then that the borough would have to make up and represents the actual cost of the street lighting for that month.

On this basis the cost of each series arc lamp per month is $4.62, and annually on a basis of October $55.55; on this basis the cost of each multiple arc lamp per month is $11.08, and annually, on a basis of October, $132.96.

In discussing this paper, Mayor Perry, of Grand Rapids, stated that his city had supplied some 500 arc lamps, all-night service, for $46.80 per year, and someone from Jamestown, N. Y., claimed a figure of $36 for a 1,200-c. p. light, with coal at $1.45 per ton, but no details were given to show what these figures really included.

THE CONTRACT OR DAY-LABOR SYSTEM FOR STREET IMPROVEMENTS.

By. J. A. Johnson, Fargo, N. D.

A large number of figures were given to show the variations in cost of paving and sewer work in different cities, presumably under the same conditions (but rarely so, in fact.—Ed.). Fargo, under the contract system, gets work done at a lower price than Minneapolis on the day-labor plan, and St. Paul, also under contract, at a lower price than either. Allowing for difference in freight rates, Fargo's work costs the least. In conclusion, Mr. Johnson said that while he believed strongly in municipal ownership, he could not with the light he now has, "advocate municipalities doing their own work."

TAXATION QUESTIONS.

There were two papers on this subject, both prepared with great care, but rather outside the scope of this journal. The paper by Mr. Lawson J. Purdy, Secretary of the New York Tax Reform Association, might well be secured and read by all interested in correcting the shameful abuses in taxation, particularly taxation of personal property, that prevail throughout the country.

GARBAGE DISPOSAL.

By Macdonough Craven, New York city.

The author stated that no method of garbage disposal has been so far developed as to be beyond competition. For cities having a garbage output of less than 20 tons a day, burning is necessary; and for cities producing over 100 tons, reduction should be adopted. The garbage of large, densely populated cities consists of 10 parts in 100 of swill, 18½ of street sweepings, 6 of rubbish and 65½ of coal ashes. American refuse contain from two to four times as much swill as European.

RELATIVE MERITS AND COSTS OF DIFFERENT PAVING MATERIALS.

By S. F. Crabbe, City Engineer, Fargo, N. D.

The life of cedar-block pavements, in the West, was placed at nine years and their cost at an average of $1.03 per sq. yd.; brick, 10 to 15 years under heavy, and 20 to 25 years under light traffic, with a cost of $2; asphalt, 18 years, with a cost of about $2.50; Kettle River sandstone, 18 years and $2. Granite block is durable, but noisy, rough and dirty. Brick is noisy.

SOME PRESENT ENGLISH MUNICIPAL TENDENCIES.

By E. W. Bemis, Mt. Vernon, N. Y.

These remarks were based on observations made while in England this summer to study evening trade schools for artisans who work during the day. The results of the study will be published by the U. S. Department of Labor. The Parliamentary inquiry relating to municipal trading (or municipal ownership) has revealed few claims of mismanagement of municipal monopolies, the objections being to the wiring of houses for electric lights, manufacture of uniforms and such undertakings by cities and towns. City engineers in England have a pretty free hand in employing and discharging laborers. Labor unions cause difficulties for both municipalities and private corporations. English municipal plants in general show more enterprise than private ones, partly because of lower capital charges and largely on account of certainty of long continuance in the business. City engineers and city clerks are selected from all over England, much the same as school superintendents and principals are here, thus affording greater opportunities for advancement to competent men.

THE CHICAGO ELECTRIC LIGHTING PLANT.

By. Edw. B. Ellicott, City Electrician.

The author believes in municipal ownership of street lights, particularly on account of the value of good lighting in relation to the safety of street passengers. As to the claim of higher wages under municipal than under private ownership, Mr. Ellicott stated that not over 30% of the cost of street lighting is for labor and that if wages were 10% higher and 10% less efficient only 6% would be added to the cost under municipal ownership. In Chicago, all the employees in the city lighting department are under the civil service.

The city of Chicago now has 4,200 arc street lamps, lighting 325 miles of streets. The cost of constructing the necessary plant has been met by general taxation, from 1887 to date. The cost of 3,500 lights, beginning with 105 in 1887, has been $2,548,000 for construction and operation, while the same number of lights under private contract would have cost $2,111,000 for yearly charges only, leaving the city with no lighting plant at the end of the period. The yearly cost of arc lights in Chicago is not over $60, but this includes neither interest or depreciation.

A total of 101 men are employed, at an average wage of $70 per month for an eight-hour day. Of the 66 men who have been on the pay rolls for two years or over, 5 have worked 13 years; 9 for 11 years; 5 for 10 years; 5 for 7 years; 10 for 6 years; 5 for 5 years; 14 for 4 years, and 13 for 3 years.

PUBLIC WATER SUPPLIES.

By Geo. A. Perry, Mayor, Grand Rapids, Mich.

The author of this paper believed in slow-sand filtration and in selling water by meter measurement, having reached these conclusions from a study of his own local needs. He also urged that all city departments using water should pay for it, that there should be no free water for any one, but that water rates should not be designed to realize a profit. He also favored a flat meter rate, with a minimum yearly charge. As to meters restricting the use of water and resulting in sanitary injury, he pointed out that the average of the meter rates of 27 cities showed that 4 bbls. of water could be had for 1 ct. Several persons discussed this paper and endorsed the use of meters.

REMUNERATION FOR FRANCHISES.

The first of the two paper on this subject was by Mr. Bird S. Coler, Comptroller of New York, who began by saying that short-term franchises are more than half the fight. In the smaller cities, selling franchises at auction may work well, but in the larger cities the complications are such that one or a few capable business men, representing the city, can make a better bargain than can be made by an auction sale. These men might be the mayor, the comptroller, both of these, or such a board of estimate and apportionment as exists in New York.

A second paper on this subject was read by Prof. C. W. Tooke, of the University of Illinois. It was a comprehensive review of the arguments in favor of various plans for franchise remuneration. The choice lies between money compensation and cheaper and improved service, the latter being preferable if only a practical means could be found for adjusting rates. Still, in addition, there should be some money compensation, and this should be a percentage of the gross receipts. If franchies are sold to the highest bidder, there should be an upset price, a limit of say 25 years, right of city purchase and no special burdens, like paving, on the company. Eventually, either municipal ownership or some plan of private ownership which includes public regulation of the rates and a division of profits between the company and city, should prevail. State Boards of Municipal Control are essential to the proper solution of this problem.

THE BENEFITS DERIVED FROM UNIFORMITY AND INDEPENDENT AUDITING OF PUBLIC ACCOUNTS.

By H. B. Henderson, State Examiner, Cheyenne, Wyo.

This was an excellent review of the subject indicated, with special reference to the experience of Wyoming. The Wyoming plan was presented in our issue of July 5, 1900, in our review of steps towards uniform accounts and statistics, and a letter on the subject, from Mr. Henderson, appeared in our issue of Aug. 9. Messrs. E. W. Bemis, Geo. R. Perry and M. N. Baker spoke on the subject, calling attention to the chaotic condition of municipal accounts in general, and the movement towards uniformity. Mr. Baker said that ten societies have now appointed committees to co-operate for improvement. Mr. Perry said that Grand Rapids had adopted a new system of accounting, providing for greater uniformity and daily cash balances, like a bank.

MUNICIPAL OWNERSHIP.

A paper on this subject by Mr. John MacVicar, of Des Moines, Ia., was read by title. Mr. S. M. Jones, Mayor of Toledo, presented a synopsis of a paper on "Obstacles to Municipal Ownership." The full paper will be printed in the proceedings. The greatest obstacle to all municipal progress he characterized by the single word, commercialism. Distrust and suspicion of city officials is another obstacle. In the future, he looked for the disappearance of party ties. He said, in conclusion: Own yourself; vote for convictions; have convictions; don't be afraid of ideals. Develop parks, music, art and other ennobling features and the improvement of more utilitarian things will follow.

By special permission, a portion of a volunteer paper against municipal ownership was read by Mr. Henry Hopkins, Superintendent of Lighting at New Haven, Conn., and ordered printed.

There were a number of other papers on various phases of municipal activity, which we are compelled to pass over as outside our scope or for lack of space.

BUSINESS AND PLEASURE.

Among the resolutions adopted was one favoring a Congressional appropriation for the Charleston Exposition, and another endorsing the movement for uniform accounting and authorizing the executive committee, through its president and secretary, or otherwise, to co-operate with other societies to that end. Another resolution endorsed the taxation reforms proposed in Mr. Purdy's paper.

The report of Mr. Thos. Taylor, Treasurer of the League, showed a balance of $18 at the beginning of the year, $1,709 of receipts from the secretary during the year, and a present balance of $31. There are outstanding bills of $423 and a claim from the secretary for $1,373 of back salary, at the rate of $125 per month. Uncollected dues amounting to $2,450 left apparent assets over liabilities of $654.

Mr. B. F. Gilkyson, Secretary, of New York city, reported that 133 cities now belonged to the League. Inquiry during the convention showed that some of these were way behind on their dues. The roll calls showed 41 cities represented at this meeting.

Jamestown, N. Y., was chosen as the place for the next meeting, the date to be fixed by the executive committee. The following officers were elected: President, J. A. Johnson, Mayor of Fargo, N. D.; Secretary, John MacVicar, ex-Mayor of Des Moines, Ia.; Treasurer, Thos. Taylor, ex-Mayor of Bridgeport, Conn.

During the stay in Charleston much was done by the municipal officers and citizens for the entertainment of the League, including a water and trolley trip to Fort Moultrie and the Isle of Palms.

THE PRELIMINARY REPORT OF THE ISTHMIAN CANAL COMMISSION.

In our issue of Nov. 29 we outlined in an editorial the prospect that the report of the Isthmian Canal Commission would favor the Nicaragua route, and that Congress would act favorably upon the bill for the construction of a canal upon this route at the present session. In our issue of Dec. 6 we printed a brief note giving the substance of the recommendations of the Commission, submitted to Congress on Dec. 4. The complete text of this preliminary report by the Commission makes a pamphlet of 44 pages. It is to be followed later by a final report giving the complete and detailed data collected by the Commission.

The commissioners were appointed on June 19, 1899; and shortly thereafter they organized and sent into the field 31 working parties of engineers Of these, 20 went into Nicaragua, with about 150 engineers and assistants; 5 into Panama, with about 20 engineers and assistants; and 6 into the Darien country, with about 50 engineers and assistants. Native laborers, boatmen, etc., made a total of over 800 in the Commission's employ. The members of the Commission, after examining existing data in the United States as to different canal routes, went to Paris and examined the data in the office of the New Panama Canal Co., and also visited the North Sea & Baltic, the Amsterdam and the Manchester canals. Later the Commission visited Nicaragua and Panama, and Mr. Morison, of the Commission, visited the parties at work in Darien.

The report then continues as follows:

FIXING THE CANAL'S DIMENSIONS.

After the commission returned to the United States much attention was given to the determination of the proper dimensions for a maritime canal under existing conditions, and the unit prices to be used in making the estimates for the cost of construction at each of the proposed routes mentioned in the law. The dimensions of the largest-sized ocean-going vessels now in use were ascertained, and correspondence was opened with leading ship builders and directors of steamship lines, at home and abroad, to ascertain the size of those now on the stocks and whether the enlargement which has been going on for many years is likely to continue, and, if so, to what extent, during the next twelve or fifteen years. The results were considered in connection with other information in reaching the conclusions upon which the estimates in this report are based, and the unit prices which were agreed upon have been applied to these dimensions.

DIMENSIONS.—A depth of 35 ft. at mean low water and a bottom width of 150 ft. were adopted as standard dimensions for a canal in excavation by each route. This width is for straight sections; on curves with a radius of less than 12,000 ft., it is increased at the rate of 1 ft. for each 200 ft. reduction of radius, the width thus becoming 180 ft. on a curve of 6,000 ft. radius. In open channels, excavated within the shallow limits of harbors or lakes, the bottom width is increased to 200 ft., in the San Juan River

to 250, and in the excavated portion of Lake Nicaragua to 300 ft. In the artificial harbors of Colon, Greytown, and Brito it is made 500 ft. These dimensions are larger than those proposed for any previous isthmian canal scheme. While they may seem excessive to-day, the canal is not likely to be opened within ten years, during which time the increase in marine dimensions which has been going on for many years is likely to continue.

The isthmian canal, except in the two maritime sections, will be a fresh-water canal. The draft of ocean steamers is based on salt water weighing 64 lbs. per cu. ft. Some large freight steamers now draw 32 ft. at sea, and would draw nearly 33 ft. in fresh water. If the heaviest class of freight steamers is to use the isthmian canal, 35 ft. is the least depth that should be adopted.

A width of 150 ft. will allow all but the very largest ships to pass each other in the excavated portions of the canal; if two such large ships meet, one will have to take the bank while the other goes by; smaller ships will pass each other and larger ships without stopping.

In soft earth or sand the estimates are based on taking out the canal with side slopes of 1 on 3 below water and 1 on 2 above water. In firm earth they are based on side slopes of 2 on 3 below a berme 10 ft. wide 6 ft. below water, and 1 on 1 above such berme. In rock they are based on vertical sides from the bottom to a berme 5 ft. above water with slopes of 4 on 1 in hard rock and 2 on 1 in soft rock above such berme, the berme being of such width that the extended slopes would intersect the bottom of the canal at the foot of the vertical sides. In certain special locations, like the Culebra cut on the Panama route, retaining walls are provided, these walls taking the place of the vertical sides of rock cuts.

The largest merchant ship now afloat is 704 ft. long and 68 ft. beam. Ships of larger displacement are now building, and freight steamers with a beam of about 75 ft. may soon be common; four such ships are now on the stocks. Battleships have a greater beam than other ocean-going vessels of like displacement; none now in the United States Navy exceeds this measurement, but designs have been prepared for some soon to be constructed with a beam of 76 ft. 10 ins. These when completed will be of greater beam than any now afloat. These sizes have been used as a basis for determining the size of locks, the governing dimensions of which have been fixed at 740 ft. long and 84 ft. wide, in the clear, with a depth of 35 ft. over the miter sills. The length, width and depth are each 2 ft. greater than those adopted by the French company for Panama. Twin locks are provided for in every case.

In special cases some of these dimensions might be changed in construction, but they have been followed in these estimates in order to make a comparison between the different routes.

UNIT PRICES.—Unit prices have been fixed by agreement of all the members of the commission, on the principle that whatever differences of opinion or circumstances may exist, they are not enough to interfere with a fair and close comparison of the different routes. These prices are as follows:

Removal of hard rock, per cu. yd.	$1.15
Removal of soft rock, per cu. yd.	.80
Removal of rock under water, per cu. yd.	4.75
Removal of earth not handled by dredge, per cu. yd.	.45
Removal of dredge material, per cu. yd.	.20
Embankments and back filling, per cu. yd.	.60
Rock in jetty construction, per cu. yd.	2.50
Stone pitching, including necessary backing, per sq. yd.	2.00
Clearing and grubbing, Nicaragua swamp sections, per acre	200.00
Other clearing and grubbing, per acre	100.00
Concrete in place, per cu. yd.	8.00
Metal in locks, exclusive of machinery, per lb.	.075
Timber in locks, per M. ft. B.M.	100.00
Operating machinery, each lock chamber	50,000.00
Power plant, each group of locks	100,000.00
Single-track railroad, complete with equipment, per mile	75,000.00

It was determined to add 20% to the estimates of the cost of construction to cover expenses that will be incurred for engineering, police, sanitation, and general contingencies. The prices are based on efficient organization and thorough equipment, with the understanding that while the work would be vigorously handled it would not be so driven as to call for unnecessary duplication of machinery. The cost of the equipment and plant will be large, but it will be distributed over a very large work.

OTHER POSSIBLE ROUTES.

The well-known geographic conditions at Tehuantepec and between the Nicaragua and Panama canal routes made it unnecessary to explore those parts of the American isthmus for other possible locations for an interoceanic canal, and the commission limited its investigations to what is generally known as the Darien country, extending from Panama to the Atrato River.

For about 80 miles the width of the isthmus in this region does not exceed 40 miles, except at one or two headlands which project beyond the general line of the coast. The narrowest point is at San Blas, where the distance from Mandinga Harbor to the shore of Panama Bay is only 31 miles, 2 miles less than from the head of the bay at Limon, at Colon, to the mouth of the Bernadino. On the eastern side of Panama Bay, about 100 miles from Panama, an estuary known as San Miguel Bay extends into the interior to within 33 miles of Caledonia Bay, on the Atlantic side. This bay of San Miguel, on the Pacific, and San Blas and Caledonia bays, on the Atlantic side, afford excellent harbors and canal approaches. Between Panama and San Blas the ridge of the Cordilleras crosses from the Pacific to the Atlantic side and continues there to the mouth of the Atrato River.

As the existence of practicable and feasible routes in this section depended upon the height and continuity of the divide, its crest was examined all along the line, with as much care and accuracy as was practicable under the conditions which existed, for the discovery of gaps and depressions, so as to ascertain whether any were sufficiently low for canal purposes, and measurements were made of those which promised the most favorable results.

The ridge was traced continuously on the ground from the head of the river Carti, a little east of Mandinga Harbor, in San Blas Bay, in latitude 9° 19′ N., longitude 78° 59′ W., to the head waters of the Chagres, and thence down the river to the Panama Railroad a total distance of 24¼ miles; also near Caledonia Bay from the Carreto summit, in latitude 8° 45′ N. and longitude 77° 38′ W., to the Sassardi summit, in latitude 8° 56′ N., longitude 77° 52′ W., a distance of 27½ miles. The lowest elevation in the former section was 956 ft., in the latter 683 ft. These results were obtained by actual leveling. Between these two sections from San Blas Bay to Caledonia Bay, a distance of 81 miles in an air line, and from Caledonia Bay southward to the Atrato River, the examination was made from the sea, the elevations of the higher peaks, as well as the gaps and their distances being determined by observations made with two sextants. The result showed that there was no probability of any suitable depression within these limits.

In addition to these investigations, a survey was made from San Miguel Bay, on the Pacific side, up the Chucunaque and Chucurti (Sucubti) rivers, which was almost though not quite connected with the work done near Caledonia Bay. After the results of the general exploration were determined, the examination of other possible routes was limited to those sections where the isthmus was narrowest, where the coast lines offered good harbors, and the indications along the divide were the most promising. These conditions were found near San Blas Bay and Caledonia Bay. East of San Miguel Bay the isthmus widens, and no route can be expected there less than a hundred miles in length.

SAN BLAS.—The San Blas route extends from the bay of that name to the mouth of the Bayano, on the Pacific; it has been advocated as the shortest line between the two oceans, which is true. The most complete plan developed involves a tunnel at least 7 miles long. While not necessarily impracticable, such a tunnel would be very objectionable and would render the line inferior either to the Panama or the Nicaragua location.

CALEDONIA BAY.—The distance from Caledonia Bay to tide water on the Savana River is about 30 miles in a straight line. Studies have been made of three lines across the divide, all of them striking the same point on the Savana River, near the mouth of the Lara, the approach upon the Atlantic side being through the three valleys of the Caledonia, the Aglaseniqua, and the Sassardi. The distance from Caledonia Bay to the mouth of the Lara varies from 32 miles by the Sassardi route to 36 by the Caledonia route. The Sassardi route has not, however, been explored through its whole length, and it is possible that an actual survey would make it as long as the Caledonia route. Each line would require a tunnel. If the Sassardi route were taken, the length of this tunnel, assuming an open cut to be used to the depth of 400 ft., would be about 1.6 miles. On either of the other two the tunnel would be about 2 miles longer, while the approaches on the south side would be much heavier.

These surveys indicate that the Sassardi route is probably the best of the three for a sea-level canal. The indication cannot be regarded as conclusive, because a thorough survey and development of the sub-surface material might show insuperable difficulties, which would be more likely to exist in the tunnel than elsewhere. The cost of a canal upon this line would be excessive and the tunnel more objectionable to navigation than the locks on the other routes.

Caledonia Bay is virtually tideless. San Miguel Bay has a tidal range of 20 ft. or more. This heavy tide causes currents in the Savana River of sufficient force to be a serious menace to navigation, and it would be necessary to build a tide lock near the mouth of the Savana. The distance from the mouth of the Lara to the tide-lock site is about 14 miles, the upper portion of which is in a narrow river which would require enlargement for a canal. This makes the total length of canal navigation from Caledonia Bay to the tide lock about 50 miles.

The result of all these examinations shows that there is no probability of the existence of any practicable canal location between Panama and the mouth of the Atrato River, except by the adoption of a tunnel line, and there seems to be no reason for further field work except in the interest of geography.

THE NICARAGUA ROUTE.

The following is the result of the investigation at Nicaragua, with a description of the route and estimate of cost:

The route lies mainly in the Republic of Nicaragua, but Costa Rica has the right of navigation in the San Juan River below Castillo, a part of which is included in the canal project. Lake Nicaragua, which forms a part of the summit level, is about 100 miles long and 45 miles wide, distant only about 12 to 30 miles from the Pacific, the longer axis being nearly parallel to the coast. The intervening territory is generally hilly, the range forming part of the continental divide.

The lake discharges through the San Juan River into the Carribbean Sea near Greytown. For the upper half of its course the San Juan flows through a hilly country, with a tortuous channel. Neither the river itself nor any of its tributaries in this section carries much sediment, and a slack-water navigation by means of locks and dams is practicable.

At the foot of this stretch the river receives from its right bank the San Carlos, its most important affluent, which discharges into it large quantities of sand. Below the confluence of these streams a slack-water navigation is not deemed practicable, and the canal route therefore leaves the river a short distance above the mouth of the tributary and is to be excavated thence to the Caribbean, a distance of about 50 miles. Below the mouth of the San Carlos, swampy bottom lands appear, crossed by several high ridges, which, starting from the flanking mountain ranges, end on the bank of the river. The easternmost of these high ridges is about 26 miles from the seacoast, but for some distance beyond low hills and groups of hills appear in place. The region is generally swampy, the surface of the ground is but little above sea level, and the soft mud sometimes extends to a depth of 30 ft. or more. A narrow strip along the coast is of sand, the gradual accretion from material brought down by the rivers from Costa Rican mountains and distributed along the coast by the waves and currents of the sea.

The project for a canal on this route follows essentially the lines laid down by the Nicaragua Canal Commission in its report, 1897-1899. It begins at the Caribbean Sea, near Greytown, follows a southwesterly course, passing to the northward of the Silico Hills, thence in a more southerly course until it reaches a point about a mile and a quarter from the San Juan River; thence it follows along the left bank of that stream, keeping a safe distance from it, until it enters the San Juan River at a point about 2 miles above the mouth of the San Carlos. The line then follows the upper San Juan to Fort San Carlos, where it enters Lake Nicaragua. After crossing the lake in a northwesterly direction to the mouth of the Rio Las Lajas, it follows the valley of that stream a short distance and crosses the continental divide into the valley of the Rio Grande on essentially the route suggested by Colonel Childs in 1850, which follows the valley of the Rio Grande to Brito, the Pacific terminus of the canal.

The following is a table of distances on the Nicaragua route:

Number of miles of canal proper	67.33
Number of miles of river improved	27.96
Number of miles of river not requiring improvement	17.26
Number of miles of lake channel 300 ft. wide	22.19
Number of miles of lake not requiring improvement	48.74
Number of miles of harbors and entrances to same	3.05
Total number of miles from ocean to ocean, measured from the 6-fathom curves	186.53

SUMMIT LEVEL.—The summit level is to be reached from the Atlantic side by five locks, the first having a lift of 36½ ft., and the other four having a uniform lift of 18½ ft. each, except the lock at the summit, the lift of which will vary with the level of the lake, being 12½ ft. when the lake is at its lowest and 18½ ft. when at its highest stage. From the Pacific side the summit will be reached by four locks of uniform lift of 28½ ft. The mean level of the two oceans is assumed to be the same. It is known that they are nearly so. The mean range of tides on the east side is about 1 ft., that on the west side is about 8 ft. Mean low tide, which is the level that determines the depth of excavation of the maritime sections, is therefore half a foot below mean sea level on the east side and 4 ft. below mean sea level on the west side. The lift of the lock at the summit, however, will vary from 22½ to 28½ ft., according to the stage of the lake, and that at the Pacific end will vary from 20½ at high to 28½ ft. at low tide.

LAKE LEVEL.—Lake Nicaragua and that portion of the San Juan River from the lake to near Boca San Carlos, and that portion of the canal on the west side between the lake and Buen Retiro, will form the summit level. From the best data available it is believed that Lake Nicaragua varies in its level, under existing conditions, as much as about 13 ft. There is good reason for believing that it sometimes goes as high as 110 and sometimes as low as 97 ft. These extreme fluctuations, however, occur only at relatively remote intervals. In order to reduce the amount of this fluctuation it is proposed to build a dam in the San Juan River, above the mouth of the San Carlos, on the east end of the summit level, and another smaller dam on the west side near Buen Retiro, to regulate the lake level.

By means of these dams and regulating works the fluctuations of the lake level can be held within the limits of 6 ft., or from 104 ft. to 110 ft. above mean sea level. The summit will be excavated to the full depth below the lower level. The data on which the solution of the problem of regulating the lake level rests are not as full as is

necessary for a rigid solution; but an approximate solution has been made, and it is believed that any errors which may exist are on the side of safety.

GREYTOWN HARBOR.—Some fifty years ago there was a good harbor at Greytown, the eastern terminus of the canal, with 30 ft. of water at the anchorage and about the same depth in the entrance. The entrance to this harbor, where it then existed, has been obliterated, and the harbor itself is now a lagoon almost entirely inclosed, of restricted area, with only about half the depth of water in it that formerly existed. Vessels for Greytown are now compelled to anchor in the offing and discharge their cargoes on lighters which are taken into the lagoon across a bar having a depth of less than 6 ft. of water. As the prevailing trade winds are strong and blow almost directly on this part of the coast, the construction of a harbor at this terminus of the canal becomes necessary in the early stages of the work, as well as for use after the canal is completed.

It is proposed to construct such a harbor, of sufficient area to accommodate vessels using the canal, by excavation, with an entrance having a least depth of 35 ft. and a bottom width of 500 ft. by the construction of two jetties springing from the shore line near Harbor Head, built of loose stone, to a height of 6 ft. above mean high tide; the hearting of each jetty to be composed of small and the outer portion of large stone, not easily moved by the waves. It is not expected, however, that the construction of the jetties alone will form an entrance. Dredging will also be necessary, and its maintenance may require an extension of the jetties or dredging, or both.

BRITO HARBOR.—The western terminus of the canal will be near Brito. Here, as at Greytown, there is no harbor, and an artificial one must be constructed. The same general engineering principles will guide in its construction. The width and depth of the entrance will be the same. The sand movement on the western coast, however, is slight as compared with that in the vicinity of Greytown. The prevailing winds on this side are offshore and destructive storms seldom visit this part of the coast. The cost of maintenance, therefore, of the harbor on the west side will be less than that of one on the east side at Greytown.

SWAMP SECTION BETWEEN GREYTOWN AND FLORIDA LAGOON.—For a part of the distance between Greytown and the Florida Lagoon the canal line passes over swampy sections, where the material is too soft to support the embankments necessary to keep out the floods of the San Juan and to maintain the canal level itself. Protecting embankments are therefore to be constructed over these sections. These embankments are to be located as far as practicable on the firm land composing the neighboring hills. In places, however, they cross ground which is soft to a considerable depth. Waste ways are provided on the embankment lines to dispose of flood water in the protected areas.

HEAVY CUTS NEAR BOCA SAN CARLOS AND TAMBORCITO.—At two places near the Boca San Carlos dam site heavy cutting is encountered, the maximum depth for short distances being 218 and 170 ft., respectively; but the deepest cut of all is at Tamborcito, about 26 miles from Greytown. Here the high ground north of the canal approaches so close to the river that a cut through it becomes imperative. The ridge is narrow, however, the width at the top being only a few feet and at the level of the water in the canal less than 3,000 ft.; but the extreme depth of the cut is 297 ft. The borings show that it is nearly all hard rock. The less heavy cuts will also be in firm ground, but the exact character of the material can not be stated until the borings now in progress have been completed.

SAN CARLOS DAM.—The most difficult engineering work in connection with the Nicaragua Canal project is the construction of a dam across the San Juan River to hold back the waters of the lake and enable its level to be regulated. It is of great importance that this dam should be located above the mouth of the San Carlos River, as the latter discharges at times as much as 100,000 cu. ft. of water per second, carrying with it great quantities of sand.

The construction of the dam below the mouth of the San Carlos, even if an eligible site were found, would, in addition to other difficulties, involve contention with the combined powers of two rivers, the San Juan proper and the San Carlos, the discharge of which may at times reach 200,000 cu. ft. per second. The Nicaragua Canal Commission made search for a dam site above the mouth of the San Carlos, in what is called the Agua Muerta (dead water). One was found at a place about 2 miles above the mouth of the San Carlos River. Several borings were made to determine the level of the rock. These indicated that good rock would be found at a maximum depth of about 14 ft. below mean sea level. The borings, however, were not sufficient in number to determine with accuracy the topography of the rock, nor its exact character. The present commission has planned three lines of borings, 100 ft. apart, at the site of this dam, the borings being spaced 100 ft. apart on each line. Hard rock for the foundation has been found, but in several places at a depth greater than the limited number of borings first taken indicated. The maximum depth to hard rock, as developed by the latest borings, is about 40 ft. below sea level, or about 100 ft. below low water in the river at the site, which will make it necessary to construct the foundaion of this part of the dam by the pneumatic process. The dam in the deepest part will then have a height of about 150 ft.

As the pneumatic process is an expensive and slow one at best, this commission has made search for an alternative site a few miles farther up the river, where the topographical and surface indications seemed to offer favorable results. One has been found which gives promise of a more satisfactory and less expensive solution of this problem, but the number of borings thus far taken is not sufficient to determine this with certainty. The estimates, therefore, are based on a dam at the site selected by the Nicaragua Canal Commission.

LOCKS.—Lock No. 1, on the east side, will have a lift of 36½ ft., but it is founded on rock. The others on the east side have a lift of 18½ ft., and are to be located on foundations that are believed to be safe. All the locks on the west side are founded on rock.

TIME.—The time required to build the Nicaragua Canal hinges almost entirely on the time required for the construction of the Boca San Carlos dam. After a harbor has been opened at Greytown, and a railroad constructed, the way will be open to attack the work from a great many points at the same time, so that if ample funds are then available, the excavation of the prism of the canal ought to be completed in a comparatively short time if prosecuted with vigor. The construction of the dam, however, will be a costly and tedious operation. Eight years would probably be a reasonable estimate for the time of building this dam. At least two years will be consumed in preparatory work and in opening a harbor at Greytown, so that if work of the dam should be commenced immediately thereafter, the time required for completing the entire work would be about ten years.

ESTIMATES.—In order to properly classify the materials to be excavated on this route many borings were necessary. In some cases where they proved unsatisfactory, slight changes have been made in the alinement of the canal. The borings have not yet all been completed, and the classification of the material, therefore, is based, in part, on surface indications and judgment. Consequently, in the final estimates, the classification which will be made from the actual borings may cause some differences. These, however, it is believed, will not materially affect the amount of the estimates.

The following is the estimated cost of a canal on the Nicaragua route:

Eastern Division (from Greytown to Boca San Carlos dam)	$82,662,000
Middle Division (from Boca San Carlos dam to Las Lajas)	25,425,000
Western Division (from Las Lajas to Brito)	51,680,000
	159,767,000
98 miles of railroad	7,350,000
Total	167,117,000
Engineering, police, sanitation, and general contingencies	33,423,000
Aggregate	200,540,000

This estimate is for a canal suitable for navigation by the largest ships now in existence, and thus in accordance with the terms of the bill pending in Congress. It provides for a double system of locks, so that navigation can be maintained if one system be closed for repairs or renewals.

The estimate of cost is much in excess of any heretofore made on this route and arises chiefly from the increased dimensions of the canal, the double system of locks, the extra cost of the San Carlos dam, due to increased depth of rock, increased embankments, and the modification in a part of the line on the eastern division, which has been located by this commission farther from the San Juan River in the interest of security.

While the project on which this estimate is based is the one recommended, a canal of smaller dimensions and reduced lockage facilities can be opened for navigation at considerably less cost. If a single lockage system only were first provided, so designed as to permit the construction ultimately of a second system, the first cost would be reduced $19,678,000. A further reduction of $16,949,000 could be made by narrowing the bottom width one-third in all the excavated channels in canal, river, and lake sections. With these reductions made the estimated cost would become $163,913,000. In such a canal the time for passage and the risks to ships would be materially greater than in the one recommended.

(Concluded next week.)

CURVES OF WEIGHT AND SPECIFICATIONS FOR ELECTRIC RAILWAY BRIDGES.

The curves shown in the accompanying diagram, prepared by Mr. H. G. Tyrrell, Assistant Engineer, Boston Bridge Works, Boston, Mass., give the weights of electric railway bridges of spans from 5 ft. to 200 ft. for both light and heavy cars. The points adjoining the curves are actual weights, and from them the curves have been plotted. The weights include the steel only, without safety stringers. The spans are proportioned for either single track or double track cars, and the load is considered to cover the span from end to end. Lighter bridges than these can, of course, be made by proportioning them for say two or three cars only on the span at one time. The units taken are 12,000 lbs. per sq. in. for tension and 10,000 lbs. reduced by Gordon's formulas for compression. The details are figured for riveted joints.

In connection with these curves it is interesting to note that the following specifications for electric railway bridges have recently been adopted by the Board of Railroad Commissioners of Massachusetts:

For bridge floors either a 20-ton 4-wheel car with 7-ft. wheel base, or a 30-ton 8-wheel car with 17-ft. total wheel base and 4-ft. truck wheel base is assumed. The fiber stresses to be used in the floor are as follows, the material being medium steel, namely: For I-beams 12,000 lbs. per sq. in., properly reduced according to the ratio

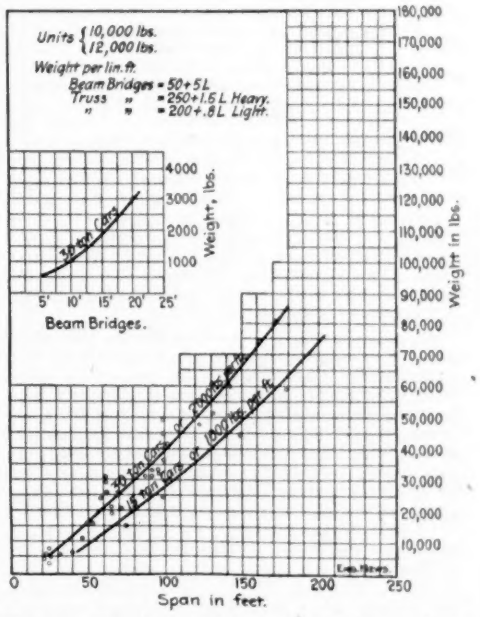

Diagram Showing Weights of Electric Railway Bridge Spans, from 5 ft. to 200 ft. in Length.

of width of flange to total length, when this ratio exceeds 20; for plates and shapes, 12,000 lbs. per sq. in., in tension, and 12,000 lbs. per sq. in., reduced by the usual formula according to the distance unsupported; for rivets in shearing, 10,000 lbs. per sq. in. and in bearing 16,000 per sq. in. for shop-driven rivets; field-driven rivets to be reduced 25% below these figures. No rivets less than ⅝-in. are to be used.

For trusses, uniform loads shall be assumed, varying according to the length which is to be covered by the live load to produce maximum stresses, from 1,500 lbs. per running foot per track for a loaded length of 100 ft. down to 1,000 lbs. per running foot of track for a loaded length of 300 ft., and proportionately for other lengths. Due account must be taken in the case of pieces which receive concentrated loading from the floor loads. The factor for trusses may be larger than that for the floor. The following may be the stresses per square inch: For tension, 15,000 lbs. per sq. in.; for compression, 12,000 lbs. reduced by the Rankine formula; for rivets the same stresses should be used as for the floor.

THE HARBIN TUNNEL, on the line to connect Vladivostock with the Russian Port Arthur Railway system, will be 7,216 ft. long, according to a St. Petersburg news item. It is also stated that an American firm has secured a $600,000 order for air compressors for this work.

FORESTRY PROTECTION IN ONTARIO, CANADA, has been engaging the attention of the authorities of that Province since 1897, when a commission was created for this purpose. Fortunately, out of the 142,000,000 acres comprising the Province of Ontario about 120,000,000 acres are still owned by the Crown; though nearly 14,000,000 acres of the Crown lands are leased to lumbermen. The present commission is now making an effort to replant with trees the large areas that are fire-swept and are not suitable for agricultural purposes, and it also proposes to regulate the timber cutting on non-tillible lands not yet denuded. A full report has been issued by Thomas Southworth, Secretary of the Commission, including a special report on forests and rainfall, presented by Mr. M. G. Butler, C. E., Ontario Land Surveyor.

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Judged by the number and quality of the papers presented, the convention of the League of American Municipalities, at Charleston, S. C., last week, was a great success. But the attendance at the various sessions was ridiculously small for an organization with a reported membership of 133 cities, each entitled to an unlimited delegation. It was a rare thing to see more than 60 delegates and guests at one of the sessions, and sometimes half that number. It is fair to say that this is not the only organization of municipal officers whose meetings are slimly attended. It looks as though the next year or two would determine whether the continuance of the League is to be justified by its work, or whether it should give way to some of the other organizations covering very much the same field. It is true that there is no other national organization whose membership is composed of mayors, aldermen and councilmen, but it is also true that nearly all the topics receiving serious attention at the Charleston meeting are being discussed by the various other organizations devoted to municipal affairs or interested in municipal economics. As we said just after the last meeting of the American Society of Municipal Improvements, and just before the meeting of the National Municipal League, it is a pity that a number of the societies devoted to municipal affairs cannot consolidate; or at least co-operate to the extent of holding their meetings at the same time and place, with some of the sessions in common. Joint effort might result in far greater strength and usefulness, and in sending more city officials to conventions where they would learn much to their own and their city's profit. There might well be a joint headquarters and library for a number of societies, the library to be composed of books on municipal affairs. The chief obstacle to such a plan seems to be an unfortunate tendency on the part of the various classes of city officials to fear that some one class will dominate the other. But the best men in each class have the very same object in view, the betterment of municipal conditions; and that being the case, co-operation should be feasible. As the major portion of the leaders in the League of American Municipalities are mayors, and, therefore, stand at the head of their respective city governments, it would be eminently fitting for the League to make an advance towards what might eventually prove to be a great national or international movement for the broadest sort of municipal co-operation. The League was never better organized and officered than now for work of just this sort, and it could undertake nothing that would appeal more strongly to those interested in good city government.

SUBSIDIES FOR AMERICAN MERCHANT VESSELS.

The ship-subsidy bill, now pending in Congress, proposes to grant to American merchant vessels engaged in foreign trade a subsidy of 1½ cts. to 3.8 cts. per gross ton of measurement for each 100 nautical miles sailed, when carrying cargo to or from the United States. The lowest rate of subsidy above named applies to vessels of low speed, which are the chief carriers of ocean freights. It is probably fair to assume that the average cargo of such a vessel on trips where she receives subsidy would amount to 75% of her gross tonnage. On this basis the subsidy of 1½ cts. per gross ton per 100 miles would be equivalent to ⅘-mill per ton of cargo carried one mile.

In a recent paper by Mr. Joseph M. Mayer before the American Society of Civil Engineers, the average rate for bulk freights on ocean steamers is estimated at ¾-mill per ton-mile. It will be seen from this that the proposed subsidy to freight steamers would be equivalent to a little over 25% of their present earnings from freight traffic.

The questions in connection with this subsidy bill turn so largely on matters of engineering and economics that some discussion of them may not be out of place in these columns.

The main argument for this bill, and the one oftenest heard, is very taking indeed at first sight. The people of the United States, it is said, are paying to the vessels sailing under foreign flags and carrying goods to and from the ports of the United States an enormous sum, estimated by the Bureau of Navigation at not less than $150,000,000 a year. Senator Frye, in his recent plea for the bill, put this argument as follows:

> Last year we paid foreign nations, principally Great Britain and Germany, $500,000 a day in gold for transporting our foreign commerce.

If it were, indeed, true that such a sum as this is being paid by the United States to foreign nations, or that it is feasible to cause those who receive this large sum to spend it in the United States instead of in foreign countries, the ship-subsidy measure might well find great popular support. Let us inquire what are the real facts of the case. What becomes of this $150,000,000 per annum, now paid to vessels carrying goods to and from the United States, and sailing under foreign flags? Where would this money go to if the hopes of the ship-subsidy promoters were realized, and a large part of this traffic were transferred to vessels under American registry?

In the first place, it must be evident that the largest part of the freight money received by any shipowner, American or foreign, is at once paid out for running expenses of the vessel. The chief of these expenses are for coal and provisions. No matter under what flag a vessel sails, these are and will be bought wherever they can be bought cheapest, and wherever the conditions of the voyage make purchases necessary. In other words, there would be no larger market for American coal and American products than now exists in supplying foreign vessels, and the proposed subsidy would effect nothing toward diverting this part of the ocean freight money from its present channel.

The next largest item in a vessel's expense account is wages. At present, except for vessels carrying United States mails, our navigation laws permit American vessels engaged in foreign trade to be manned by crews of any nationality; the officers, however, must be American citizens. In the pending bill, all vessels receiving the subsidy are required to have at least one-fourth of their crew American citizens, or those who have taken out their first naturalization papers. Without questioning the good intentions of those who drafted this bill, it is extremely doubtful whether it would really result in any increased demand or higher wages for American seamen. The conditions under which crews of merchant vessels are shipped are pretty well known. Keepers of sailors' boarding-houses and others who make a business of supplying crews to merchant vessels are not as a class endowed with the most sensitive consciences, and it will be easy for them to make almost any sort of timber pass as American citizens. If a sailor says he was born in the United States, who shall dispute his word? Besides this, the bill provides that if the stipulated quota of American citizens "cannot reasonably be obtained, men of other nationalities may be shipped."

Taking all these well-known facts into consideration, it is hard to believe that the proposed subsidy bill can really effect anything in causing Americans instead of foreigners to be employed as sailors in the American merchant marine. If wages and conditions of life on vessels sailing under any flag are made such as to attract American workingmen to them, the number of American sailors on the high seas will be increased; but it is extremely doubtful whether legislation can accomplish this.

It is indeed true that one argument for the bill is that legislation has fixed a higher standard for space and for food for the crew on American vessels than obtains on foreign vessels with which they are in competition. Hence, it is argued, the subsidy is needed to offset this handicap of the American vessel. On the other hand, it is claimed by those familiar with ocean traffic that these laws designed to benefit the sailor are little observed, and are practically impossible of enforcement. While the need of legislation in the interest of labor employed on the high seas must be admitted, the fact that the sailors' labor organizations are opposed to rather than in favor of the bill, certainly raises a doubt as to whether the subsidy would really benefit in any degree the man in the forecastle or the fire-room.

Continuing our analysis, a considerable item in the ship's expenses is insurance. The business of marine insurance is one absolutely open to all nations. Nothing in the proposed law would change the direction of the insurance payments, even if all the ocean commerce of the United States were transferred to vessels flying the stars and stripes. The same thing may be said regarding the matters of inspection, banking and similar expenses incident to the shipping business. American capital can engage in these fields of enterprise now. It has indeed to meet the competition of foreign firms of long standing; but it would still have to do this even were the proposed subsidy bill a law, for the American shipowner, like the foreign, will get his insurance wherever he can best obtain it, regardless, of nationality.

Finally, a part of this $150,000,000 which we have assumed as the cost of ocean carriage upon the imports and exports of the United States, goes as profits to the owners of the vessels. Will the proposed subsidy effect a diversion here? Will profits which now go to Englishmen or Germans or Norwegians be transferred to Americans? In answering this question, it must be remembered that capital, under modern commercial conditions, is no longer subject to national bounds. For example, the last report of the Commissioner of Navigation shows over 300,000 tons of shipping sailing under foreign flags, but owned by American capital. Any American can to-day purchase shares, if he desires, in British or German or French steamship companies; and on the other hand, any foreigner can purchase interests in American shipping companies, just as he can buy American railway securities. This very subsidy bill now before Congress contains nothing whatever to prevent foreigners from owning any amount of shares they please in the transportation companies, which would receive the subsidies that the bill provides. In fact, should the bill pass, it would be entirely possible for a promoter to go to England or Germany and raise capital

there for shipping companies to operate under and receive the benefits of the proposed bill.

We are aware that the United States navigation laws forbid a foreigner from owning any interest in a vessel having American registry; but this requirement is practically a dead letter in the case of vessels owned by shipping companies. The stocks and bonds of these corporations are bought and sold like the stocks and bonds of a railway or industrial company. If the company is incorporated in the United States, no inquiry is made by the Government as to the actual owners of its stocks and bonds. In fact, it would be difficult to frame legislation of this sort that could not be readily evaded.

Even if it were possible to make sure that none of this proposed subsidy would finally reach the pockets of foreigners interested in American shipping, it may well be doubted whether either the public or its representatives in Congress would favor a subsidy bill if it were clearly understood that its chief beneficiaries were to be the owners of capital. It most certainly would not do so, however, if the benefit was as much open to foreigners as to citizens of the United States.

We do not point this out as a defect in the bill. It is a difficulty inherent in every attempt to subsidize commercial enterprise. The plain fact is that capital in these modern days is too fluid—too easily transferred from place to place—to restrict such benefits to any nationality. This is a fortunate economic fact—not a misfortune. It ensures the widest possible competition among owners of capital; and it has been one of the chief factors in reducing the percentage of the products of industry paid to the capitalist, and increasing the amount left to divide among the actual workers of all degrees.

From the above simple discussion, it seems clear enough that the proposed subsidy bill, if it effected the transfer of our carrying trade to the United States flag, would not greatly change, after all, the final disposition of the money now paid for ocean freights on our imports and exports. On the other hand, it is true that changes are already in progress, in obedience to economic laws, and these changes would doubtless be accelerated by the proposed Government subsidy. The nature and effect of these changes is worth a moment's notice. The first and most important of these is the transfer of the center of cheap steel production from Great Britain to the United States. It was England's cheap iron and steel that gave her pre-eminence as the great ship building nation of the world, when the iron steamer displaced the wooden sailing ship. With the cheapest ships at her command, a people fond of a seafaring life and of eminent commercial instincts, together with the largest store of capital of any civilized nation, it was no wonder that she rapidly became also the chief ship-owning nation.

He must be indeed blind to the signs of the times, however, who does not perceive that this primacy cannot endure. The United States, with its enormous stores of cheap coal, cheap iron ore, and cheap capital, is now making steel plates, transporting them 500 miles to the seaboard and across the Atlantic and laying them down in British shipyards at a less cost than they can be supplied by British steel-makers. With this great advantage in his favor, why should the American shipbuilder require Government aid to enable him to compete with his foreign rival? Is it because the American steel-plate maker charges the American shipbuilder a pool price for his plates, but sells to the foreign shipyard at a price fixed by foreign competition? That such a condition exists at times was pointed out by a leading shipbuilder in a recent published paper*; but surely Congress should find some better remedy for this than an appropriation from the national treasury. If the man who finds his business handicapped because of trust extortions is to be entitled to Government aid, Congress has a huger task on its hands than it has ever tackled.

It will be apparent, and is in fact admitted by the advocates of the ship-subsidy bill, that its purpose is to aid the American shipbuilder quite as much as the American shipowner. But is a Government subsidy necessary to secure the continued growth of the shipbuilding industry? There lies before us a recent bulletin of the U. S. Bureau of Statistics, in which it is shown that the exports of manufactured iron and steel from the United States in the current year will reach $140,000,000 in value. Ten years ago these exports amounted to only $25,000,000. Now a modern steamship is only a great mass of manufactured iron and steel. We work steel plates and shapes into bridges, and send them to Asia and Africa and Europe; but these same plates and shapes are the chief material of a ship's hull. Huge steam engines are brought a thousand miles to the seacoast, sent across the Atlantic and set up in English cities in competition with English builders. If these things are done with stationary engines, does the builder of marine engines require Government aid to enable him to compete with his foreign rival?

It is, of course, true that English shipbuilders have built up a huge business, and they have a present advantage in being able to carry on work on an enormous scale, and in the possession of an established organization. British capitalists, moreover, are so familiar with all branches of maritime industry that they are ready to furnish capital for it at a lower rate than it can be secured for in the United States.

On the other hand, the American shipbuilder has (or should have) the advantages of cheaper material; labor which if more highly paid is also more efficient; a greater use of labor-saving machinery; plants which can be brought up to date and which are free from the obsolete machinery and methods which are to be found in many British works.

In his speech favoring the bill on Dec. 4, Senator Frye said:

> Is the committee correct in its statement that it costs more to build and more to operate an American ship than it costs our commercial rivals to build and operate theirs? If the committee is mistaken in this respect, then the foundation of this bill falls through.

Undoubtedly it has cost more in the past to build ships in the United States, and to operate them under its flag than the similar expenses for foreign vessels; but is the past an index to the future? Is not the time so plainly in sight when American shipbuilders and shipowners can stand on their own legs that to grant Government aid for a period of twenty years in advance would be distinctly unwise? It was urged in favor of the bill in a recent Congressional debate that it would so increase the business of American shipyards that they would in five years be able to build vessels as cheaply as Great Britain. If this is true, why should it be necessary to saddle a subsidy payment of $9,000,000 per annum upon the nation for twenty years to come?

The principle of fostering special industries by direct payments from the National treasury is a new one for the United States; and even those who most ardently support it will hardly deny that it is looked upon with great disfavor by a large proportion of the public. It is true that a large number of commercial organizations have formally declared in favor of Government aid to the merchant marine; but no astute politician would make the mistake of overestimating such declarations as a barometer of public opinion.

That there are sound reasons for desiring an increase in the American merchant marine, we are far from denying; nor can it be denied that Government aid in some form would act as a stimulus to its growth. The carriage of the mails, the maintenance of regular steamer communication between the United States and foreign ports, the training of American seamen who can be drawn upon to replenish our naval forces in time of war, the construction of merchant vessels in such a manner that they may be most readily made use of as auxiliary cruisers and transports in time of necessity—all these are directions in which the Government may reasonably expend the public funds, and may do it in such a manner as to foster at the same time the growth of the merchant marine.

Such measures, coupled, if possible, with a reform in the navigation laws which would dispense with some of the red-tape that now hampers the shipping industry, and the relief of that industry from all state and local taxation, should be sufficient to attract to it an abundance of American capital.

*Engineering News, Nov. 22, 1900; p. 353.

LETTERS TO THE EDITOR.

Concerning the Shrinkage of Earthwork.

Sir: "Be sure you are right and then go ahead" and "be sure you are wrong before you back down," are, I suppose, equally wise injunctions. Now in the matter of Shrinkage of Earthwork, concerning which a statement in my "Surveying" has started an active controversy in your columns, I am not sure of anything, and I don't know that any one else is. There does seem to be a high probability, however, that the rule I gave, of an ultimate shrinkage from first fill to final volume of 1-6, is in error so far as the central and eastern portion of the United States is concerned, and for the ordinary methods of moving earth. Mr. Flynn had practiced only in India and in California, I believe, and his work was probably all done in a dry season, in which there may have been no rain during the progress of the work.

The ordinary contractor would delight in such conditions and probably would be willing to add one-sixth to the height of his dump if he could do his work in such weather. I can only say that I did my best to arrive at some authority for shrinkage, and I took what seemed to be the best available. And as against the "general experience" of engineers who have never made accurate measurements, I suspect Mr. Flynn's measured results would still stand.

However, I will agree to change the definite statement to an indefinite (and therefore meaningless) one, in the next edition of the work (which will be the sixteenth) in the hope that I may no longer mislead my readers even if I fail to lead them. When this edition appears I will take pleasure in sending Mr. J. L. Campbell and my other critics complimentary copies of the book, which I hope will then be without offense.

To be consistent, also, I should now make my acknowledgments to the editor, and say that after all my protests his little sermon has borne good fruit and that the chief kicker got the greatest benefit! Very truly yours,

J. B. Johnson.

Madison, Wis., Dec. 15, 1900.

Sir: Relative to the shrinkage of embankments after construction; since Prof. Johnson's letter and my own appeared in Engineering News (Nov. 15) two other letters have appeared in later issues, and I have received several personal letters, one of which from Mr. Wm. M. Andrews, Assistant Engineer Mississippi Levee Board, is especially instructive, as it clears up the matter of allowance for shrinkage in Mississippi levees. Prof. Johnson has correctly stated the fact that the "average allowance for shrinkage is 17%," but Mr. Andrews' explanation makes clear the error that any man is liable to fall into if he does not inquire the reasons for any particular clause of a specification. I shall now quote from Mr. Andrews' letter:

> The requirements for wheelbarrow work have changed somewhat in ten years, but only to prevent if possible, the employment of barrows, as such work is not regarded as being equal to team work. Our present practice is 10% shrinkage allowance for team work and 25% for barrow work. On sand soils we regard 10% as ample shrinkage on team work, but in loam and buckshot it is hardly enough. The "shrinkage" in these soils is not altogether shrinkage though, but is due in part to settlement (in the buckshot) consequent upon widening of the base by the embankment cracking open in the hot months and then dissolving and filling these cracks in the wet season. I have seen cracks which would hold half of a man's body.
>
> In loam soils the levees often "squat" or flatten out during the wet season or during the flood period. The question of determining the proper amount of shrinkage is further complicated by the unstable character of the foundation which we must use under our levees. Do not understand me to say that the longitudinal cracking and settling is incident to any but our buckshot levees or that it is the only way they settle. But I do say that settlement of foundations, cracking and squatting of the embankment (thereby altering its form but not its volume) are largely blamed to shrinkage in the embankment itself.
>
> As I before remarked, it is hard to draw the line, so we attempt to compensate for them all, except in unusual cases, by adding 10% shrinkage.

I think it will now be admitted that the allowance made in the levee specifications is partly in the nature of a factor of safety to avoid topping the bank by any chance "squatting" or extraordinary settlement; and that, as Mr. Andrews says, the allowance is not for shrinkage proper, as Prof. Johnson has assumed.

It is evident that Mr. J. L. Campbell made a perfectly correct inference in what he said in his recent letter: "The fact that levees are built for a 10% settlement vertically, as mentioned by Prof. Johnson, proves nothing unless it is shown that they settle to grade, which has not been done."

Mr. Chas. H. Tutton, in his letter appearing in your issue of Nov. 22, appears to have misunderstood my criticism of Prof. Johnson's rule: for I did not state absolutely that a 3% shrinkage is a maximum but only far nearer an average than Prof. Johnson's 16 2-3% allowance. Mr. Tutton gives two experiments, one showing 5% shrinkage and one 9% shrinkage, which, I believe, he will now concede does not "look like a direct contradiction of Mr. Gillette's statement." No one is seeking anything but the truth, and if I have underestimated average shrinkage

I desire to know it. I am convinced of one thing: That Prof. Johnson was led into error by reasoning from Mr. Specht's experiment, and he will himself doubtless be glad to know the truth. It is to be hoped that other engineers having exact data will submit their observations to Engineering News. H. P. Gillette.

751 Powers Block, Rochester, N. Y.
Dec. 17, 1900.

How They Do Things in Nebraska.

Sir: On page No. 171 of the Supplement to your issue of Nov. 22 you publish a notice of a bridge letting to take place at Plattsmouth, Neb., on Dec 7, 1900, the work to be let consisting of yearly work for 1901.

We went to Plattsmouth yesterday, Dec. 7, to bid on the work and were informed by one of the County Commissioners and the County Clerk that the work was let Dec. 1, as advertised in two county papers. We were, however, not the only unfortunates present, as the Midland Bridge Co. and A. M. Blodgett, both of Kansas City, Mo., had representatives there.

We learned from one of the commissioners that the successful bidder was J. R. Sheeley, of Lincoln, Neb., and from other parties that it was a "put up job," they, the county, advertising the work to be let Dec 1, after notifying the engineering papers that the work was to be let Dec. 7, 1900.

The reason we write you is that we feel as if you should know what is going on and to find out if there is no way of getting reliable news in advance regarding bridge lettings.

We trust that you will look into this matter as soon as possible, as we would be pleased to know whether you have an authentic letter from the County Clerk giving Dec. 7 as the date set to let the work. Yours very truly,

Kansas City Bridge Co.,
D. L. Hammond, Secretary-Treasurer.

Kansas City, Mo., Dec. 8, 1900.

(On receipt of the above letter, investigation was made in this office and the item was found to be based upon a letter written on the stationery of the County Clerk's office and dated Nov. 8. It is reproduced herewith in fac simile:

Office of
The County Clerk,
Cass County.

Plattsmouth, Neb., Nov 8th 1900

Engineering News
New York N.Y.

Gentlemen: Sealed Bids will be received at the office of the County Clerk of Cass County Neb. until noon (12 o'clock) Dec 7th 1900 for building all bridges that may be ordered for a period of one year beginning Jan 1st 1900 - All bids to be accompanied by Plans and Specifications and a certified check for $500.

Address James Robertson
County Clerk

On finding the above letter we at once wrote to the County Clerk, stating the facts as reported by the Kansas City Bridge Co. and requesting an explanation as to how we and our readers were thus misled. His letter received in reply is as follows:

Office of
The County Clerk, James Robertson, Clerk.
Cass County. William Coolidge, Deputy.
Plattsmouth, Neb., Dec. 14, 1900.

Charles Whiting Baker, Managing Editor Engineering News, 220 Broadway, New York:

Dear Sir: Your favor of Dec. 12, 1900, received. In answer I will say that I did not write to you on Nov. the 8th or on any other date. The Board of County Commissioners ordered the notice published in two home papers and I did not send a notice to any one else. If you received a letter with my name signed to it, it is a forgery.

Truly yours, James Robertson, County Clerk.

(The above letter is written on the same stationery as the letter reproduced in fac simile above, but is in an entirely different handwriting. Apparently an investigation is in order by the authorities of Cass county, Neb. If some one had interest enough to mislead outside bridge companies as to the date on which an important public contract was to be let, the matter is one of interest to the taxpayers as well as to the firms who were put to needless expense through this misleading information.—Ed.)

Notes and Queries.

In the article on "The Laying Out of Towns and The Planning of a Model Industrial City" in our issue of Dec. 6, 1900, an error was made in stating that the elevation of the main part of the new Zion City would be 11½ ft. above the level of Lake Michigan. Mr. Burton J. Ashley, the Chief Engineer, writes that this 11½ ft. refers to the elevation of the floor of the new lace factory which is now being constructed, and that the elevation of the main part of the city above the lake will be from 40 ft. to 100 ft.

Our attention has been called to two errors in the reprint in our issue of Dec. 6 of the paper, "The Power Required by Centrifugal Blowers and Fans," which was read before the recent meeting of the American Society of Mechanical Engineers. In the equation which reads,

$$\frac{144}{16 \times .078} = 1{,}154 \text{ ft.},$$

the latter number should be changed to 115.4 ft. The equation $V = \sqrt{2gh}$ should be $V = 60\sqrt{2gh}$. The first error appeared in the paper as originally printed by the Society of Mechanical Engineers.

Mr. D. H. Davison, Minonk, Ill., sends the following problem in spherical trigonometry. Any of our readers desiring to submit solutions should send them directly to him:

The track of the Illinois Central R. R. from Kappa to Lostant, a distance of 32 miles, is laid on a straight line. In Minonk, Ill., at a point in the middle of this straight line, in Lat. N. 40° 53', and Lon. 89° 3' W. of Greenwich, the true polar bearing of the road is N. 4° 38' W. Required, the true polar bearing of the R. R. at Kappa and also at Lostant. If this straight line be extended around the earth, on what meridian will it cross the equator and what is the true polar bearing of the line at that place? Also, what is the Lat. and Lon. of the place where the line runs due west, at the nearest point it approaches the North Pole?

A correspondent in Marion, O., writes:

This city is having considerable trouble in finding a successful method of repairing cracks in its asphalt pavements. The cracks run from the curb toward the center of the street and were originally repaired by cutting them out and refilling the crevice with new asphalt. In many instances where these repairs were made the asphalt has cracked anew on each side of the narrow strip of asphalt filling. Is there any better method of making these repairs than the one adopted?

In reference to this matter Mr. Geo. W. Tillson, in his recent book on "Street Pavements and Paving Materials," says:

A pavement that is laid soft will seldom give trouble by cracking except after it has been laid a long time. In western and northern cities where the range of temperature is great, it is probably impossible to lay sheet asphalt pavements that will not crack in extremely cold weather. The best method of taking care of the cracks is to prevent them, or where not possible to do that entirely, to devise, by a study of the conditions, a composition that will withstand changes of temperature to the best advantage.

We shall be glad to hear from any of our readers who have had experience in meeting the trouble mentioned by our correspondent.

The standards of track construction of the Canadian Pacific Ry., which were given in our issue of Aug. 30, have been corrected by Mr. D. McNicoll, Second Vice-President and General Manager, although the information given in the tables above referred to was obtained from official sources. According to the information now furnished by Mr. McNicoll, the standard spikes are of the Goldie pattern and the Bonzano joint is the standard rail joint. The rails are laid with square joints on tangents and broken joints on curves. The weight of angle bars is 76 lbs. per pair for 80-lb. rails, and 100 lbs. for 100-lb rails; the bolts are ⅞ × 4½ ins. for 80-lb., and 1 × 5½ ins. for 100-lb. rails. Plate nut locks are used. Ties must be not less than 6 ins. wide. The average life of ties is 8 years for tamarack, 6 years for hemlock, and 8 years for Douglas fir. Spruce is not used. The Glendon tie-plate, ¼ × 5 × 8¼ ins. is adopted for 100-lb. rails, and the tie-plates for 80-lb. rails are of the same size but of various makes. The standard frogs are the MacPherson (with unbroken main rail) and the Eureka spring-rail frog. The standard switches are of the split and MacPherson types, with switch rails 18 ft. long for 100-lb. rails and 15 ft. for 80-lb. rails. Rigid and automatic switchstands are used.

EXPERT VALUATION OF RAILWAY AND OTHER CORPORATE PROPERTY IN MICHIGAN.

Doubtless the most accurate valuation of railway property that has ever been undertaken in this country is that which is now in progress under the direction of the Michigan Board of State Tax Commissioners. This body was created by the legislature in 1899, and is composed of Milo D. Campbell (Chairman), of Coldwater; Robert Oakman, of Detroit; and Amariah F. Freeman, of Manchester. In the message of Gov. Pingree to the extra session of the legislature in October, it was shown from a statement of the Tax Commission that the full value of the tangible property of one road (the Ann Arbor R. R.) was $5,700,061, and taking 65% of the full cash value for assessment gives $3,705,105. The taxes on earnings paid in 1899 amounted to $39,406, or 1.06% of the 65% assessment. With a rate of taxation of 2%, the taxes on this assessed value would have been $74,102. The actual average rate of taxation throughout the State, however, was 1.547%, instead of 2%. On one other road (the Detroit, Grand Haven & Milwaukee R. R.) the taxes on earnings paid in 1899 were $31,610, only 0.87% of the assessed valuation. A 2% tax on this valuation would have given $68,107, while a 2% tax on the full value would have been $104,780.

The object of the appraisal or valuation is simply to establish the value of the property, and thereby show the rate of taxation now being paid by the railways. It has nothing to do necessarily with the actual question of increase in taxes, though it may be noted that the valuation was ordered with a view to the establishment of ad valorem taxes instead of the present system of specific taxes. That, however, will be a matter for the State legislature to deal with, working on the basis of the results developed by the present investigation.

In brief, the work consists in the inspection and valuation of every part of the physical property owned by the railways. This valuation gives in the first place the estimated value of each item as new work, material or equipment. Every item, however (whether grading, a bridge, a locomotive, a shop tool or a building, etc.) is given a percentage mark for "condition," representing the relation which the actual existing value bears to the estimated value for renewal or replacement. In estimating the cost of individual items, the market price or an average price for a term of years was used, according to circumstances, as is more fully explained later; but no attempt was made to ascertain or use prices actually paid by the railways.

This investigation applies not only to the railways, but also to telegraph and telephone companies, express companies, private car lines, and plank road and river improvement companies. The difficulties and complications involved in the work will be shown further on. One of the most remarkable and important features of the entire

work is its entire freedom from political control, and its execution exclusively by experts, a large proportion of whom are engineers of high standing.

The State legislature in 1899 passed an act supplementary to the General Tax Law, creating a Board of Tax Commissioners, and the principal provisions of this act, relating to the work of valuation dealt with in this article, were as follows:

It shall be the duty of the said Board to inquire into and ascertain the value of the properties of corporations paying specific taxes under any of the laws of this state, and to ascertain the actual rate of taxation as based upon the valuation of said properties that is being paid by said corporations. To this end, said Board shall require reports from, and make investigation as to the properties of such corporations in the same manner and to the same extent as if said corporations were paying taxes under this act.

The Board shall further report to the legislature at the beginning of the regular sessions, specifically, the true valuation of the properties of corporations paying specific taxes, and the rate of taxation actually paid on said valuation. Also the true valuation of all other properties of the state and the rate of taxation the same are paying, to the end that the legislature shall have the information necessary to rearrange the rate or system of taxation on said properties, so that all taxable properties of the state may be taxed uniformly.

ORGANIZATION.

On Sept. 1, 1900, Prof. Mortimer E. Cooley, M. Am. Soc. M. E., of the University of Michigan was appointed by the Board of State Tax Commissioners as Appraiser of Properties Paying Specific Taxes, and was directed to commence an appraisal of the physical property of all the railways and other corporations paying specific taxes in the State of Michigan. Immediately upon the appointment of Prof. Cooley as appraiser, the organization of the force was commenced, a system of blank forms for reporting was prepared, and the organization of the field inspection staff was taken in hand. The maximum force aggregated about 100 men, all employed strictly on the basis of professional merit without regard to politics or place of residence. Most of the men were civil and mechanical engineers, and over 90% were graduates of engineering colleges or technical schools, some 15 institutions being represented. A large number were also members of the American Society of Civil Engineers or the American Society of Mechanical Engineers. Many of the minor positions were filled by young engineering graduates from various institutions. A statement of the professional records of the men engaged on this work shows quite a remarkable aggregation of men of wide experience and high qualifications. We give herewith a list of the principal members, which will indicate that the work has not been that of one or two good men with a number of subordinates, but rather that of an entire staff of able men. One reason for this was the necessity of carrying on the work with the greatest possible rapidity, as the investigation included over 57,000 sq. miles of territory and 10,000 miles of railway, while a report to the Board was required before the end of the current year. It was necessary, therefore, that the men should be able to go ahead on general instructions, on their own responsibility, and not to rely upon constant help from headquarters, which would have involved continual delays.

Prof. M. E. Cooley, M. Am. Soc. M. E., as Appraiser, was the head of the entire force; Mr. Henry E. Riggs, M. Am. Soc. C. E., of Toledo, Ohio, Chief Inspector in Charge of Civil Engineering; Mr. T. H. Hinchman, Jr., M. Am. Soc. M. E., Detroit, Mich., Chief Inspector in Charge of Mechanical Engineering; Mr. D. Farrand Henry, M. Am. Soc. C. E., Detroit, Mich., Chief Inspector of Plank Roads and River Improvement Companies; Mr. Wm. S. Conant, M. Am. Soc. M. E., Detroit, Mich., Chief Inspector of Telegraphs; Mr. Wm. J. Rice, of New York, Chief Inspector of Telephones; Mr. Herbert C. Sadler, M. Inst. Nav. Arch. & Marine Engrs., Chief Inspector of Vessel Properties; Mr. F. G. Susimihl, of Michigan, Architect.

The final settlement of various questions and knotty points which arose in formulating the basis for the valuation of certain items, together with a review of the methods and final results, were submitted to a special Board of Review composed of Messrs. Octave Chanute, of Chicago; Charles Hansel, of New York; Prof. Chas. E. Greene, of Ann Arbor, Mich.; and Col. G. W. Vaughn, of Chicago. All of these gentlemen are members of the American Society of Civil Engineers, and not having been engaged in the detail work were able to take a broad view of the matters submitted to them, while their names are sufficient to indicate their competency to pass upon these matters.

By far the most extensive and important work of the commission was the valuation of the railway properties, and this work was divided between two main departments, as follows: (1) Roadway, Bridges and Buildings; (2) Motive Power, Rolling Stock and Shop Machinery. Besides these, there were other departments, as follows: (3) Telegraph Lines; (4) Telephone Companies; (5) Plank-road and River Improvement Companies; (6) Private Car Lines; (7) Express Companies.

The investigation and the field inspection brought to light 53 unincorporated railways, of which there was no record, and which have paid no taxes. They are, of course, built on land owned or purchased by the owners of the railways, as without incorporation they would have no power to institute proceedings for the condemnation of land. The aggregate length of these roads was about 500 miles. Most of the lines are logging and mineral railways, but some are over 60 miles long and carry on a regular passenger and freight traffic.

Having now explained the purpose and scope of the work, and the general organization of the force, we may proceed to consider the matter more in detail. The work of obtaining the information from the offices of the railway companies was begun on Sept. 15, and on Sept. 25 the first field inspection was commenced on the Ann Arbor R. R. While the railways declined to allow the appraiser full access to their books, plans and records, they were as a rule very willing to furnish all information desired. In fact, without this co-operation on the part of the railways, it would have been impossible to complete the appraisal within the time required by the law. In view of these conditions, a number of blank forms were prepared, about 30 in all. These were of uniform size, 14 × 8½ ins., and called for information relative to alinement and profile, right of way and real estate, mileage, rails and ties, station buildings, miscellaneous buildings, stock yards, bridges, drawbridges, culverts, arches, interlocking plants, crossing protection, engine houses and turntables, fuel stations, water stations, motive power equipment, freight and passenger car equipment, miscellaneous equipment, shop machinery, docks and wharves, steamers (car ferry steamers, etc.), telegraph and telephone lines, and miscellaneous questions. The headings of some of these are given herewith, and illustrate the character of the information obtained. The work was divided as follows:

1. OFFICE INSPECTION.—This comprised the securing of statistical information. Employees of the department were sent to the engineers' offices of the various railways in parties of 3 to 20 men, and all of the blank forms were filled out with data secured by an inspection of the maps, profiles and other records.

2. FIELD INSPECTION.—The records secured from the office inspection were turned over to the various field inspectors, all of whom were civil or mechanical engineers of wide experience, and many of whom had formerly been chief engineers of railways. The field inspection was made with hand cars or velocipede cars, or on foot, a careful, personal inspection being given each structure on the line of the property. Careful estimates of embankment, excavation, clearing, grubbing, classification and examination of all bridges, buildings, rails, ties, and structures of all kinds, were made. Alterations and changes were made to bring the record strictly up to date. The present value was represented by a percentage based on 100% as the value of a new structure of the same class, the deterioration being indicated by the application of the percentage considered by the field inspectors to fairly represent the present value.

3. VALUATION.—The calculation was taken up in the office upon the completion of the field inspection reports. The field and office notes were carefully checked, and the value of a new railway of the same class determined, every item being considered and valued separately. At the same time, the present value was determined by the application of the percentages shown by field inspection. A maximum depreciation of 60% was taken for all railway equipment and material. In a few cases of very ancient and dilapidated structures, etc., an even greater depreciation was allowed, but in general such conditions would be balanced by an impending increase of value due to renewal or reconstruction. In the great majority of cases, renewals or repairs are made before the property is in such condition as to be given this maximum rate of depreciation.

ROADWAY, BRIDGES AND STRUCTURES.

The office inspection was done under varying conditions. In some cases many obstacles were placed in the way of an accurate and rapid conclusion, while in others, every courtesy was shown, and a very satisfactory record was obtained without difficulty. The work implied a search of the records of each road, and the making of notations of all tracks, roadway details, bridges and structures upon the blanks already noted. The methods of keeping records in the engineering and maintenance offices were found to be largely at variance. The work was required to be quickly done, and for each man employed, records of from 35 to 40 miles a day were taken. It would not seem that so much could be done with any accuracy, but the fact remains that in many instances the field inspection checks closely with the office inspection. Mr. W. L. Trowbridge states that in making this search they endeavored to reduce the work of the coming field inspection as much as possible, the men making such additions to the blanks as seemed best to convey the desired information:

In the case of side tracks, we secured, where possible, a list giving location, local name and length; but in no case were we able to find a record of weight of rail in sidetracks, and in very few instances were reliable records of th renewals obtainable where a profile was shown to be reasonably accurate, and in case the engineering department knew the width of roadbed, quantities were taken off: This feature proved a valuable one in the final compilation of the report, checking the field inspectors' estimates; and in a few instances where the profile was of late date, it was only necessary for the field inspector to keep track of the width of roadbed, and in a general way note the heavy work and classify the material.

The condition of office records, or rather the lack of any, upon many of the smaller roads, is deplorable. Some of these roads have not had an engineer in their employ for years. Others, while having engineers, do not allow them sufficient assistance to compile a set of records, nor the time to do it themselves; or, through a false economy, employ a cheap man and get (what they pay for) cheap results. Upon the larger roads, some of the records are excellent; but upon others, there is a jealousy between the several departments which would be difficult to properly define; yet it results in an incomplete set of records, which is not kept up to date, while had the whole machine worked in harmony, we would have found reports such that our problem would have been simplified materially throughout the state.

The field inspector's duty was to check the office records, by going over the line of road, taking account and fixing percentages of all tangible property listed and unlisted. The records obtained by the office inspection (above noted) and tabulated on blank forms, were turned over to the field inspector, who was equipped with tapes, a 6-ft. rule, field books, blank forms, etc.

Arriving at the starting point on the road to which he had been assigned, he proceeded to inspect carefully, and to place percentages of conditions on all the physical features within the scope of his department. In the absence of complete engineering records from the office, as occasionally happened on roads where engineers are not deemed a necessary feature of railway practice, and were there no records, the inspectors had to measure and estimate everything from right of way to (but not including) rolling stock. Under favorable conditions of weather and a competent hand-car force, 20 to 30 miles per day have been inspected.

The list of headings on the field inspection blank is given herewith. This was supplemented by detail notes in the field book, which should be transparent enough to enable any engineer to estimate the cost of reproducing the line in its present condition.

COMPUTATIONS.—To facilitate work in the of-

fice, tables were compiled covering all classes of railway construction, material and structures, values being figured out for various percentages of "condition." Thus the price of new rails, ties, switches, track scales, turntables, etc., were given for various weights and styles, together with the values of the same materials at different percentages in regard to condition, with allowance for wear, scrap value, etc. The prices for rails were taken as an average of the prices of the past ten years, but in most other cases the prices were based upon present market conditions. The tables were prepared by a conference of field inspectors and others, and it is believed that they represent prices which may be fairly applied in all parts of the State. In certain cases, as for ties and trestles, a deduction was made for the northern part of the State, where lumber is more plentiful. The tedious work of making calculations for special structures to which the tables were not applicable demonstrated that a great amount of time had been saved by the use of such tables. They were typewritten and mounted on tarred boards for convenient use in the computing room. Copies of some of these tables are given herewith.

The unit prices for those items of cost generally entering into railway construction were determined after much careful consideration and discussion by about 15 men, most of whom had at some time taken part in the construction of Michigan railways. It was believed that one set of prices would apply to all roads in the State, and this has, with few exceptions, been found to be true. While for materials not obtainable within the State, the freight charges to different parts would vary, these variations are not as great as would at first appear, because to those parts most remote from the markets, materials are generally shipped by boat at a rate much lower than by rail.

For earthwork there was adopted the single price of 17 cts. per cu. yd., with no allowance for haul. The price adopted for rails (the average price for the last ten years) is $28 per ton for new rails and $12 for scrap. Having fixed these prices, the next step was to arrange them for the most convenient and rapid use. For this purpose, the unit of measure was taken at one mile wherever possible. For example: The unit price of oak ties having been fixed at 55 cts. per tie, this price was converted to $1,452 per mile, for a spacing of 15 ties per rail-length, and corresponding prices per mile for other spacings. Rails, rail fastenings, ballast, clearing and grubbing, fencing and tracklaying, surfacing, etc., were estimated by the mile, so that having obtained the quantity of any item in miles, it remained only to multiply by the unit price per mile to obtain the total.

The depreciation of materials and structures was estimated by the field inspectors and expressed by a percentage of total service remaining in the item. Thus, in the case of a trestle three years old, the life of which was considered to be 10 years, the inspector noted it at 70%. This does not mean that age and total life were always the determining factors in fixing the percentage of condition, because in many cases an inquiry, or some peculiar local conditions, would affect the condition of a structure in ways that are not at all uniform.

Tables were computed for all the different items based on the established unit prices, but showing the price per mile or other convenient unit for each 10% of condition from 100% down, as shown by the accompanying examples. By this arrangement the numerical work was reduced to a minimum. For instance: with 10 miles of oak ties, 17 ties per rail, condition 60%, the price per mile ($987.36) was taken directly from the table and but one multiplication was necessary. Prices of culverts and trestles were made per lineal foot. Buildings were estimated by the cubic foot, modified by whatever collateral evidence could be obtained of the cost. Special buildings involving unusual architectural features were treated separately. Rails, rail fastenings, frogs, switches and crossings having scrap values were estimated somewhat differently. For example: The price of new rails being $28, and the scrap price $12, the wearing value was $16; if the "condition" of a rail was 60%, the unit price was 60% of $16, plus $12, or $21.60; and the corresponding price per mile for, say, a 56-lb. rail, was $1,900.80, and was taken directly from the table.

After the calculations were completed and checked, they were sent to the compiling room, where they were reviewed, and a typewritten report prepared. The system of classification adopted was that of the Interstate Commerce Commission's "classification of construction expenses." Some slight modifications were introduced, a few of the items being subdivided in the appraiser's classification. The typewritten report of each road showed a short specification or description of each bridge, station, locomotive, car, shop tool, etc., with (1) its estimated cost, if purchased new, (2) the percentage of condition (as before explained), and (3) the present net value (1 × 2). A summary report on a single sheet also shows for each railway the 37 items of classification, with "cost of reproduction" in one column, and "present value" in another. It also shows separately the mileage of main line and of branches, spurs and sidings.

FILING.—The following description of the system of filing adopted for the blanks and records is furnished by Mr. A. V. Gifford, who is in charge of this work.

In filing the reports of office and field inspectors two points have been kept in mind: (1) To make the files as complete as possible, with the minimum amount of red tape;" and, (2) to so arrange our own reports and the method of keeping the records, that the complete information or any part of it, could be taken out any number of times a day without causing any great amount of labor or taking too much time to keep the files in order. The numbering of the roads was based upon the list prepared by the Railroad Commissioners, consisting of 78 railways and 7 ore and forest roads. Blank numbers were left from 85 to 100, for other incorporated roads not already included, and the numbers from 100 upwards were given to unincorporated roads, of which there were about 75. (About 50 unincorporated and unrecorded railways were discovered by the inspection.—Ed.)

Very large envelopes of heavy paper were used to keep the reports in, on the outside being placed the number of the road and its list number. These in turn were kept in pigeon holes, numbered in consecutive order. An index book was kept, one page being devoted to each road and subdivided in three headings: Office Reports, Field Reports and General Office Reports. On the margin of each sheet, as it came in, was stamped the road number, R. R. & B. (standing for the Department of Roadway, Bridges and Buildings), and a sheet number. If the sheet was made out by the office inspectors in the various railway offices, it was entered in the Office Report column; if by a field inspector, in the field, it was entered in the Field Report column; or, if a computation was made in the Tax Commissioners' office, it was entered in the General Office column.

As soon as the field inspection had been completed on any road, that road was marked with a blue line on a railway map of the state. When the office calculations were completed, this road was also marked with a red line. A glance, therefore at either the index or map showed how far the work on any road had progressed.

This system worked satisfactorily on the roads of moderate length, and whose reports were not too numerous. On some of the large systems of the state, it was found convenient to sub-letter the reports according to the different divisions, sometimes adopting the system's divisions and sometimes adopting divisions according to field inspection. For instance: No. 24 had six parts—24, 24A, 24B, etc.—each filed and indexed as a separate road.

The method of giving out reports was a simplification of the library system. One man was put in charge of the filing and vault in which the records were kept, and no records were taken out or put in except by him. Each man in the office had an envelope with his name on it, and a card inside. When he wanted papers relating to a particular railway he wrote on the card the date and number of the road (or parts of the road), and this was put into the pigeonhole in place of the records he took out. When he returned the records, the number was checked off on the card and his envelope returned to him. The index showed what reports were at hand, and the small envelopes showed where all records were that were out.

This entire system, though extremely simple, proved adequate to our needs, and was very flexible, permitting a free handling of records that could not have been done with a more elaborate system, without a great loss of time and a great deal of labor.

STAFF.—The field inspectors of the Department of Roadway, Bridges and Buildings were as follows: Richard B. Wick, of West Virginia; E. D. Miller, of Illinois; Andrew J. Wenzell, M. W. Soc. C. E., of Michigan; John J. Hubbell, of Michigan; Roscoe C. Young, of Canada; George W. Tonson, of Ohio; Emory W. Muenscher, M. Am. Soc. C. E., of Michigan; Wm. H. Jennings, of Ohio; A. K. Nash, of Illinois; Wm. B. Ewing, M. Am. Soc. C. E., of Illinois; F. E. Bissell, M. Am. Soc. C. E., of Illinois; G. E. Drew, of Michigan; Owen C. Lesuer, of Kansas; Louis Shaw, of Vermont; Wm. Dunbar Jenkins, M. Am. Soc. C. E.; J. J. Reynolds, M. W. Soc. C. E.; J. C. Oliphant, of Ohio; Albert J. Himes, M. Am. Soc. C. E., of New York; and Edwin J. Trowbridge, of Ohio.

Mr. G. H. Hutchinson, M. Am. Soc. C. E., of Pennsylvania, was in charge of docks, wharves, ore docks, etc.; Mr. Edward C. Dunbar, in charge of land and right of way; Mr. J. J. Reynolds, in charge of the appraisal of the Detroit Terminal properties; Mr. Elliott F. Moorse, in charge of interlocking and signals; Mr. Frank T. Oakley, M. Am. Soc. C. E., and Mr. Frank H. Alfred, in charge of the calculating office; Mr. F. T. Barcroft, M. W. Soc. C. E., compiler. Other engineers and graduates on the force were as follows: C. A. Shackford, H. L. Cleverdon, Assoc. M. Am. Soc. C. E.; John C. Setser, Alfred E. Lindau, James Walker, Leslie McHarg, Paul Chipman, Edwin M. Smith, Harry V. Gifford, M. E. Far-

MICHIGAN RAILROAD APPRAISAL. **FIELD INSPECTION REPORT.** T. C. Form B. R. 1

_____ Railroad. *Between* _____ *and* _____ *Miles* _____ *Number of Tracks* _____ *Ties, C. to C.* _____

Date _____ *Highest schedule passenger train* _____ *miles per hour, Freight* _____ *miles per hour.* _____ *Inspector.*

MILE	GRADE		TIES		RAIL		BALLAST		FENCE		FROGS and SWITCHES			CROSSINGS		DRAINAGE	ALIGNMENT	REMARKS
	Vertical	Gradients	Kind	Condition	Kept	Condition	Kind	Condition	Kind	Condition	Number	Kind	Condition	Number	Condition			

Field Inspection Report of Department of Roadway, Bridges and Buildings.

MICHIGAN RAILROAD APPRAISAL. T. C. Form B. R. 7

_____ Railroad. **BRIDGES**

Date _____

Include all wooden, steel or combination trusses, all girders and I beam spans—If solid floor and ballast please so state.

Bridge Number	LOCATION	NAME OF STREAM	FOUNDATION					SUPERSTRUCTURE									Date Built
			Stone or Pile Abutments	Stone or Concrete Piers	PIERS	Approx. Cub. Ft. Masonry in Abutments	Number of Ft. Piling and Sq. Ft. in Water	Number of Spans	KIND	Length out to out	Specification for Loading Required	No. Panels	No. Size and Kind of Stringers	Size and Kind of Beams	How Supported	Size of Ties	

Bridge Record for Office Inspection.

T. C. Form B. R. 3

MICHIGAN RAILROAD APPRAISAL. **ALIGNMENT AND PROFILE IN MICHIGAN.**

_____ Railroad

Date _____

DIVISIONS OF ROAD		ALIGNMENT							PROFILE					
FROM	TO	Length Miles	Number of Curves	Aggregate Length of Curved Line, Miles	Aggregate Length of Straight Line, Miles	Number of Curves over 3 Degrees	Total Curvature over 3 Degrees	What is Degree of Maximum Curve	Aggregate Length of Level Grades	Sum of Ascents, Feet	Sum of Descents, Feet	Number of Miles 0.5% to 1%	Number of Miles Grade Over 1%	What is rate your Maximum Grade and what their length Miles

Alinement and Profile Record for Office Inspection.

SAMPLE HEADINGS OF BLANKS USED IN MICHIGAN RAILWAY APPRAISAL.

shall, Ralph C. Smith, W. F. Dow, Frank S. Whitman, and Donald S. McCalman.

DEPARTMENT OF ROLLING STOCK AND SHOP MACHINERY.

This department was charged with obtaining records and information and making valuations of all the locomotives, passenger and freight cars, special equipment (snow plows, pile drivers, wrecking cars, etc.), shop machinery, and supplies. There were 8 freight car inspectors (working in pairs), 3 locomotive inspectors, 3 passenger car inspectors, 1 inspector of miscellaneous equipment, and 1 inspector for shop machinery. These were in addition to the office force. In order to ensure uniformity in the inspection, the 8 car inspectors were worked together under instructions for a time, until they all had the same general ideas of how to make the inspection, and how to make their valuation of the car expressed as a percentage of the value of a new car of the same type. Each man had a stamping hammer marked "M. T." (Michigan Tax) with which he stamped the end of the needle beam, so that the car would not be reinspected. These car inspectors were sent to various points and (one on each side of a train) inspected every car, whether of a home or foreign road, noting on special blanks, the number of the car, its type, dimensions, brake equipment, character of trucks, etc. These blanks were returned to the office and tabulated. From 10% to 35% of the cars of each road were thus inspected. The number of locomotives and cars owned by each railway were readily obtained from official and published records. In order to obtain the necessary figures as a basis for valuation, complete specifications of representative engines and cars by different builders were sent to the builders of these engines or cars with a request to state the price, or an average price for 10 years. In no case was the name of the road given, there being no desire to get contract prices actually paid by the railways. Thus, if the price for a locomotive of a particular type was $7,000, and an inspector noted the "condition" of such an engine as 50%, the "actual value" would be listed as $3,500. The same practice was followed with cars, shop tools, etc. The records show for every railway a description of each engine, each passenger car, a certain proportion of its freight cars, and every shop tool. The cost, percentage and actual value are also recorded. Each inspector had also a note-book, and these, with the record blanks and tabulated sheets are all filed in somewhat the same way as those of the Department of Roadway, Bridges and Buildings.

To aid in determining the value of locomotives, the values were plotted for engines of different weights in order to establish a curve, and this proved to be practically a straight line. This was for new engines. Values allowing for deterioration, scrap value and important repairs were also plotted, establishing curves which enabled the value of an engine of a certain weight and condition to be determined from the diagram. The annual depreciation would give a straight diagonal line for the value of the engine, year by year, but when the important repairs were considered, which of course offset the depreciation, the plotted line developed a curve above the line for depreciation alone, and showing a higher value. For railways having but a short mileage in the State, it was decided to adopt a valuation based upon the car mileage within the State.

STAFF.—Mr. T. F. Hinchman, Jr., M. Am. Soc. C. E., was at the head of this department. Mr. F. M. Dunlap, M. Am. Soc. M. E., was Chief Inspector of Freight Equipment, assisted by Joseph Perrien, M. Am. Soc. M. E.; M. W. Campau, James Hoover, V. P. Moore, C. Kayner, J. Wallace and S. A. Foster. Mr. H. C. Anderson was Chief Inspector of Locomotives, assisted by J. A. Davies and H. R. Harvey. Mr. J. S. Thompson was Chief Inspector of Passenger Equipment, assisted by Wm. Wanless and G. A. Sutter (both formerly master car-builders). Mr. J. A. Slack was Inspector of Shop Machinery and Supplies; and Mr. G. L. Lewis was Inspector of Special Machinery (pile drivers, steam shovels, wrecking outfits, etc.).

LAND VALUATION.

The following statement of the method by which the land values of the Appraisal were deduced has been prepared by Mr. E. C. Dunbar, who was in charge of this part of the work:

The limited time in which full results had to be made known precluded the general adoption of any of the usual methods of land valuation and for that reason the following method was adopted. The office inspectors took direct from the maps and other records of the railway companies and the Register of Deeds all the information necessary to determine the area of the railway land throughout the State. They sub-divided the land, in taking it off by counties, and also subdivided it so that the right of way between stations showed separately from the right of way and additional land at stations, or at points where the density of population would enhance the value of land beyond that of farm land. In the cities, the land was all divided into small blocks, so that it might be estimated either by square feet or by the front foot, as might seem most expedient.

As the land throughout the State is not uniform in quality, the railway lands were subdivided into 83 subdivisions, following county lines. And on the basis of its physical characteristics, it was also subdivided into six separate classes: (1) Farm land; (2) Barren land; (3) Towns under 500 population; (4) Towns under 3,000; (5) Towns under 10,000; (6) Towns over 10,000 population.

To determine the percentage of farm and waste land on each railway, in each county, a representative was sent to each of the railway centers of the State. He interviewed roadmasters, locomotive enginemen, and freight train conductors, as being men who knew the land over which the railway passed, and from them secured the desired information. In the smaller cities and a few of the larger villages, the quality of the land was determined by our representative going over the land within the city, and classifying it according to the uses to which the various properties were put: (1) Laborers' residence property; (2) Mechanics' residence property; (3) High-class residence property; (4) Manufacturing property; (5) Second-class store; (6) First-class store property. He also got local experts to value each division.

The price of the land in the first five classes, except as before noted, was determined by sending a letter of inquiry, enclosing a card for reply, to some 500 representative citizens of the State, taking about six from each county and choosing these citizens from among land dealers, bankers, county surveyors and county treasurers. Each man selected was supposed to be peculiarly adapted as a judge of land values within his county, and on the card enclosed he was requested to give his estimate of the present value of an average acre of land in his county in each of the five classes. It will be observed that this method assumes that every acre of land of the same class, in a county, is equally valuable and that that value may fairly be taken to be the average price of the land of that class in that county. An average of the prices by classes as given on the cards for each county was, therefore, taken as the present valuation for the first four classes and partly for the fifth. For part of the fifth and all of the sixth, the price was determined in the usual manner by a Board of Experts; going over every foot of the property in question and valuing each piece separately, taking into consideration surrounding values, both from selling prices of adjoining land and assessment rolls.

Acreage Valuation.

Right of Way and Station Grounds ..... County.

AUTHORITY	RAILROAD	PRESENT VALUE PER ACRE.				
		FARM LAND	BARREN LAND	TOWNS UNDER 500 POP.	TOWNS UNDER 3,000 POP.	TOWNS UNDER 10,000 POP.

Heading of Card for Record of Land Valuation; Michigan Railway Appraisal.

Our method of accumulating this information was by means of a card index file. The cards were 6 ins. wide and 3 ins. high, with columns and headings as shown below. Each had nine black lines, the last line being for the assessor's appraisal. One card was made for each county through which each railway passed. It is evident, therefore, that by applying the average prices to the class quantities, determined as above described, each card would represent the total present market value of all the land belonging to the railway in question in that particular county, and the sum of the values given on all the cards, for any given railway (that is one card for each county) would equal the actual present market value of all the land owned by that railway in the State. The total of all the cards would equal the total present value of all the railway lands in the State.

The question arose in our minds at the outset whether in addressing 500 strangers, nearly all of whom were busy men, we should get any considerable number of replies to our inquiry, and if we did, whether they would not be mere off-hand guesses rather than thoughtful estimates. It is extremely gratifying to be able to say that out of the 500 persons less than fifty have failed to respond. In only one case was the failure to comply with the request based upon the plea of no compensation, and of all the answers received there is scarcely one that does not bear, either in itself or in an accompanying letter, evidence of the most painstaking care. It was noticed in many instances that before making out his card the writer would correspond with from five to twelve different persons in his county, getting their views and then summarizing them on his card. I do not believe that had we gone over every acre of the land in this State, with a Board of Inspection and Valuation, at enormous expense, we would have arrived at any better result than we did by the inexpensive and expeditious method detailed above.

VESSELS.

Mr. Sadler, who is now Professor of Naval Architecture at the University of Michigan, made a thorough inspection of the car ferry steamers and placed a value upon them, together with a percentage representing the present condition, in accordance with the system already described.

TELEGRAPH.

The inspection and valuation of all the telegraph lines in the State was entrusted to Mr. Wm. S. Conant, consulting engineer, of Detroit. Linemen and operators were employed as inspectors, and many of these men had been engaged in the construction of the lines. This division of the work also included the telephone lines owned by the railway companies. The inspections were made mainly from the rear cars of trains, notes being made in a field book of the height and top diameter of poles, number of poles per mile, number of cross-arms and how secured, insulators and pins or brackets, sizes of iron or copper wires, number of wires, and condition of the construction. Lines parallel with or crossing the railway were also noted. At small stations the inspector would quickly determine the office instrument equipment by a glance into the operator's office. At large stations, a regular inspection was made. The apportionment of the valuation was a matter of no little difficulty. In many cases the poles owned by a telegraph company are placed on railway land and carry both railway and private wires, while the case is further complicated by wires strung under special arrangements or with special privileges for a term of years.

At the end of each day's inspection, the results noted in the field book were filled in on special blanks, one for line construction and the other for instrument and station equipment. These blanks were sent to the office, and the final statement for each railway was entered up by the office inspectors on another blank, classifying the different sizes of poles, cross-arms, wire, etc., and giving in the first column the number or quantity of each. The next column showed the cost of each item as placed ready for use, including both material and labor. This, multiplied by the number or quantity, gave the cost of reproduction for the next column, followed by the percentage of condition and the resultant "present value." The depreciation of much of the equipment was taken as 5% per annum, with a maximum depreciation of 60%, as in all the railway equipment, it being assumed that the necessity of maintaining the line in condition would preclude the owners from letting the value drop below this point. The prices used as a basis for the valuation represented market prices with the regular trade discounts for material in large quantities. For copper wire, however, the average of prices for 10 years was taken, as this price is so fluctuating.

TELEPHONE COMPANIES.

This department, which was under the direction of Mr. Wm. J. Rice, of New York, was independent of the railway work, and covered the property of all companies operating a telephone system. The State records showed 64 companies; investigation developed that 20 of these had gone out of business, or had been absorbed by other companies, while there were 19 new companies discovered by field inspectors, bringing the present total up to 63. The inspection of the lines was made in somewhat the same way as that of telegraph lines, already described. A summary sheet has been prepared for each separate company, showing the various classes of equipment and construction, together with an itemized valuation of each. Exchange districts have been reported separately from toll lines.

The plan followed in other departments in arriving at the cost of reproduction by calculating each separate item at a fixed price, including labor and material for each, has been carried out in this department. The present value of the equipment was arrived at by applying to cost of

reproduction a certain percentage of depreciation, governed by the condition and quality of construction as reported by field inspectors. As a matter of information and interest, the total number of subscribers for each company is shown, and an average per subscriber derived for the different classes of construction and equipment.

The preparation of schedule of prices for material and labor, as well as depreciation rates, necessitated considerable preliminary work and besides the knowledge and experience of those connected with the department, information was obtained from various telephone companies and manufacturers of telephone equipment. The sources from which this information was drawn were found to differ considerably in their ideas as to fair depreciation rates. For instance, in Boston it was considered that a deterioration of 7½% should be allowed for underground cable, while for the same equipment in Chicago 12½% was reported; 10% was selected for the Michigan appraisal. While underground conduit in Chicago is figured at a depreciation of 5% per annum, in Boston it is figured at 3½%. In the same way a considerable difference was noted from the various parts of the country, and the basis finally arrived at in this work was chosen as a medium.

In this class of work, as compared with telegraph work, more depreciation has been allowed for the reason that telephone lines must necessarily be maintained at a much higher standard of construction to produce satisfactory results. Where a depreciation has been allowed on telegraph lines of 5% per annum, 8% has been taken for telephone lines.

The following is an extract of the rules followed in regard to the telephone valuation.

COST OF REPRODUCTION.—With the exception of copper, current prices have been used for labor and material, it being considered that the current prices are not subject to fluctuations and will not be materially lower in the future. For copper wire, however, which has been subject to and will continue to fluctuate, an average price for the past seven years has been used. Where different prices are noted for similar classes of equipment the same may be interpreted to signify a difference in character and quality of construction.

RATE OF DEPRECIATION.—An arbitrary figure of 40% of cost of reproduction has been taken, below which no depreciation has been allowed, if the equipment is still in use or likely to be continued in use. If not in use or not likely to be used again, its junk value only has been taken. This applies to all the following equipment:

POLES AND CROSS ARMS.—Accepting about twelve years as the average life of a pole line, a depreciation has been allowed of 8% per annum.

WIRE.—As explained above, the cost of reproduction of copper wire has been taken from the average price for the past seven years. Inasmuch as the cost of copper wire is figured from its weight, its value does not differ materially regardless of its length of service. As 80% has been taken as the junk value of all copper wire in use, no depreciation has been allowed below that figure. For copper wire in use 1 year or less its full value will be taken.

For 2 years and less than 3 years,							2½%.
" 3	"	"	"	"	5	"	5%
" 5	"	"	"	"	10	"	10%
" 10	"	"	over,				20%

UNDERGROUND CONDUIT.—A depreciation has been allowed of 2%.

CABLE.—For both aerial and underground (lead covered and rubber) cable a depreciation has been allowed of 10% per annum.

SUBMARINE CABLE.—In all cases this material has been treated specially, the same general conditions not being met with in different pieces of submarine cable.

SUBSCRIBERS' STATIONS EQUIPMENT.—Accepting ten years as the average length of time that this equipment is used, or can be used, a depreciation has been allowed of 10% per annum.

SWITCHBOARDS.—Under general conditions, a central office installation does not exceed an average length of life of ten years. A depreciation has, therefore, been allowed of 10% per annum.

RIVER IMPROVEMENTS AND PLANK ROADS.

These two divisions of the appraisal were under the direction of Mr. D. Farrand Henry, M. Am. Soc. C. E., of Detroit, assisted by Mr. E. W. Muenscher, M. Am. Soc. C. E.

RIVER IMPROVEMENTS.—The improvements which enter into the inquiry for appraisal include only those undertaken by incorporated companies, and are largely carried out for logging purposes. In many cases logs are cut near the upper reaches of rivers where there is insufficient water to float them. Dams are therefore constructed to impound the water above these points, and when it has reached a certain height, flood gates are opened and the rush of water carries the logs down stream until they are again stranded. The same operation is repeated until the logs reach water deep enough to float them. In addition to this, the same companies frequently enlarge and extend their improvements by means of canals, locks, etc., making waterways navigable for small craft. Under the existing statutes, these companies pay a specific tax upon their capital stock. The valuation of the property, however, would include (1) improvements in the bed of the river by deepening, widening or removing bars and obstructions; (2) the cost of dams, flood gates, canals, locks, etc.; (3) the value of real estate owned and occupied, and (4) the cost of maintenance and operation, including wages of employees. Many of these river improvements are of no particular direct value to the owners, but are undertaken for the purpose of holding the river against competitors. Where the logs of one company have to pass the dams of other companies lower down the stream, the latter charge a small toll. A short canal connecting Portage Lake with Torch Lake, in the upper peninsula, has been built to enable large lake steamers to reach the Calumet & Hecla mining property on Torch Lake. A small toll is charged for vessels passing through.

In regard to the utilization of water power, we give the following extract from a statement prepared by Mr. Henry:

A third improvement in the utilization of the power of the stream. This is nominally assessed by the proper officers, but as they rarely have any idea of the manner of computing the value of such properties, commonly only the real estate is assessed and the power (the most valuable asset) goes free. It would seem to be eminently proper for the Tax Commissioners to ascertain the value of such water powers, so that the assessors could be advised of their worth and put them on their books.

For this purpose it will be necessary to find the cost of the dams and race-ways or flumes, and the value of the real estate and buildings. Then, to compute the value of the power, the total fall and average amount of water passing through the race must be measured; and from this the nominal HP. can be calculated. The actual HP. is often as low as 75% of the nominal HP., even when good turbines are used. At Niagara Falls, the regular charge for power at the Falls is $10 per HP. per year, and at many Eastern mills it is two or three times as much.* In fact, there is hardly any place in the country where so little is charged for power. Probably, a just value to put upon the plant, considering the price of fuel here, would be $10 per nominal HP. per year, capitalized at 5% less the yearly cost of repairs. The length of time of capitalization would depend upon the present value of the plant and its probable life.

Of course, to accurately estimate the power, a long series of observations would be necessary. Doubtless only a portion of the possible power of the race is being utilized at the wheels, and it would be just to take as a basis the amount they were using. Each case should be judged on its merits and the most equitable value selected.

PLANK ROADS.—These are toll roads built by incorporated companies, but they have now been largely taken over by the township and county authorities and the private interests thereby extinguished. Few of the companies keep complete or accurate records and the work of valuation has been done largely by personal inspection and measurement. Some of the roads are built of plank, as the term implies, laid directly upon the roadbed or upon sleepers. Others are built of gravel, cinders, slag, etc., etc., the substitution being permitted by the charter. The toll houses and gates have also to be valued, and account taken of the number of toll-gate men, road men, office men, etc., employed; and also the annual outlay for repairs of road, gates and buildings. The traffic and income from traffic have also to be considered.

The number of plank road charters is 202, some of which are duplicates; these cover 4,877 miles of road and represent a nominal capital of $10,000,000. Only 83 companies did any work, and the operated roads aggregated 1,027 miles. The paid-up capital (or original cost of the roads) was $1,992,000. Only 24 of the companies ever paid any of the very light taxes required by the statute. The total taxes paid have amounted to $22,561. There are 23 plank road companies still operating, the roads aggregating 229½ miles, and the paid-up capital being $543,800. If the rate of taxation of 1% on capital stock, which was fixed by some of the early charters, had been enforced, the tax would have been $5,438, whereas the whole amount collected in 1899 was only $911, four companies not paying anything. The original cost of the roads, as given, was very unreliable. In the valuation, therefore, the cost of a good new road was taken, and from that was deducted the cost of resurfacing, the difference being the present value of the road.

*In 1898, the rate for power from Niagara delivered on the consumer's premises at Buffalo, was $22.35 per HP. per annum.—Ed.

SYSTEM OF FIELD INSPECTION.

The general system of field inspection has already been described, but it may be of interest to refer to the methods adopted in keeping record of the men, keeping in communication with them, and making them feel that they were in constant touch with the head office. Every man was instructed to send in a letter or postal card every day, even if he had nothing to report, and to promptly and continually forward all information, blanks and reports. The head office, in turn, took special care to follow up every man, by letter, telegram or long-distance telephone, giving him instructions and information. In the office was a map of the State, mounted on a board, and a number of pins were provided, each having a tag bearing the name of an inspector. The pins had heads of different colors, representing the different departments. These pins were constantly shifted according to the latest information as to the movements of the inspectors.

Quite a little difficulty was experienced at first in making the inspectors fully understand that their work had nothing whatever to do with taxation, but simply that they were to make a valuation strictly from an engineering point of view. Several of the men were at first disposed to put down values suitable for taxation, according to their ideas. The following is an abstract of the instructions issued to inspectors:

INSTRUCTIONS TO INSPECTORS.

The public at large is not interested in your part of the work, and it will avoid annoyance if you refrain from giving information to those who can be of no service to you. This office will furnish all data to newspapers.

The time allowed for our work is so short that it will be necessary to put in as long hours as possible in the office, and in the field to work from daylight till dark. Inspectors are expected to work as long hours as possible.

You are expected to report daily your route and the point where you will receive mail or telegrams. Always give name of hotel or office where mail may be directed.

Report to this office all pile drivers, steam shovels or other construction equipment, and point at which you found it working. This is for the benefit of the office in sending out inspectors.

On completion of your work on each road send in all blanks in your possession connected with that road.

In case of property, such as buildings, which might not be readily evaluated in the office from data given, give an estimate of cost of reproduction.

Make such memoranda as to the character of property adjacent to station grounds as will assist in placing proper land values.

You are expected, as an engineer, to make an estimate from which the cost of reproducing the road may be obtained. You will be held accountable for your failure to report fully on any items of cost of roadway or structures.

In case you encounter a bridge, building or other structure, representing a large outlay of money, and the evaluation of which in your opinion requires a special expert, notify this office, giving location and description of the structure.

SPECIAL INSTRUCTIONS TO INSPECTORS OF LOCOMOTIVES.—Each inspector must thoroughly inspect every locomotive found in territory to which he has been assigned.

All data as to numbers, classes, dimensions, capacities, weights, etc., are to be obtained as far as possible from the office record of the road. It is advisable to obtain these data in advance of inspection.

Send in report daily of all work completed.

The value of each engine is reported in per cent. of a new engine of the same class, the new to be 100%.

In case an engine is undergoing repairs at the time of your inspection, you should consider it as an engine coming out of the shop on the day of your inspection.

Each inspector should endeavor to inspect as many engines cold as possible, and examine fire-box and tube-sheet thoroughly. If boiler is not steel make a note of same.

Each inspector should keep complete record of all engines inspected, so as to avoid a second inspection.

SPECIAL INSTRUCTIONS TO CAR INSPECTORS.—In describing car bodies, say: Flat, Gond., Coal, Box, Stock, Furn., etc. Ref.—for refrigerator, stating kind or name of patent, as "Wickes," etc.

If air brake, add A. after description. If common or patent roof add C. or P. (as Box A. P. for box car with air brakes and any of the roofs other than common boards).

Trucks: D—diamond, and W. C. or S. added—wood, compound or steel bolster and spring plank. Fox or Schoen pressed steel trucks, Fox or Sh. is sufficient.

Valuation to be expressed in per cent. of a new car, of the same class, the new to be 100%.

SPECIAL INSTRUCTIONS TO INSPECTORS OF ROADWAY BRIDGES AND BUILDINGS.

OFFICE INSPECTION.—(1) Fill all blanks fully as possible from data in engineer's office.

In case absolute information is lacking on any point and approximate data is given, plainly state the fact, so that field inspectors can verify report.

If profiles of road can be secured for purpose of estimating grade it will expedite work. If profiles are in condition for such work notify the office at once.

Such data as to original cost of any structure as is given will be reported to the office. It is not desirable that such information be given the field inspectors.

Any property of which there is record and which is not called for by any of the report forms, is to be noted, and

this office advised at once. Inspectors will make it their duty to secure all information as to property connected with track or track structures.

FIELD INSPECTION.—Field inspection is to be made of all property in the State. Note kind and condition of all property, forwarding daily field reports to the office each night, and at the completion of your work on each road, forwarding the office data, with your notations as to value and with blanks which were not filled in the office, filled out from observation in the field.

Note all property, and in case any is not listed in the office blanks, make full report on same.

There are many buildings on the company right-of-way owned by private parties. Secure information as to character and condition of building and name of owner, so that the question of taxation can be looked up.

You will be furnished a book in which you will make all notes outside of those called for by blank forms. This book must contain all side notes taken by you. It will be filled, without skipping pages or making notes at random, and when full, it will be indexed and sent in. Each memorandum must be dated and be fully self-explanatory.

You are especially directed to make careful estimates of grade. In many cases it will be impossible to secure data from the offices, and on the accuracy of your report and estimates will depend the value of the appraisal.

All property will be reported upon as to condition, by a percentage. This percentage will represent the condition of the property as compared with a new structure of the same class.

FINANCIAL.

The cost of the work of appraisal is estimated to amount to about $50,000. No regular or fixed appropriations for work of this kind are made under the laws of Michigan, but the bills of special commissions are submitted monthly to a Board of Auditors composed of the Secretary of State, the State Treasurer and the State Land Commission. These bills must be itemized to the smallest particular for every individual, and they are published in full in the annual report of the Board. This enables a close check to be kept upon the expenditures and prevents the waste of money where the proper expenditures do not reach the limit of a fixed appropriation.

The salaries paid ranged from $100 to $175 per month for the office force and from $200 to $350 per month for field inspectors. These latter salaries were made large enough to enable the men to pay their own hotel bills and other subsistence expenses, presenting monthly itemized bills only for street car fares and other incidental transportation here of men to assist in measuring, etc. These bills and the vouchers for salaries were sent by the Appraiser to the Tax Commission and then by the usual channels reached the State Treasurer, and were paid by checks sent through the Appraiser.

For transportation, mileage books were purchased by the State, the inspector depositing the $10 guarantee required by the railway. This system was not everywhere available and on some lines tickets from station to station were issued on orders from the Appraiser. No railway passes were asked for, received or used in any case.

VALUATION OF FRANCHISES AND INTANGIBLE PROPERTY.

In addition to the system of appraisal described in the foregoing part of this article, a special independent investigation as to the value of the franchises of the companies is being made for the Tax Commissioners by Prof. Henry C. Adams, the statistician of the Interstate Commerce Commission. This report will be based in part on the results of the appraisal, which are furnished to him by the Tax Commission. Other investigations are also being made as to valuations based upon traffic, earnings, and capital conditions. We give below a quotation from a statement made by Prof. Adams to the Tax Commission in October, explaining his rule for the appraisal of the immaterial values of railway properties, or what he prefers to term the "Capitalization of corporate organization and business opportunity:"

(1) Begin with gross earnings from operation, deduct therefrom the aggregate of operating expenses, and the remainder may be termed the "Income from Operation." To this should be added "Income of Corporate Investments," giving a sum which may be termed "Total Income," and which represents the amount at the disposal of the corporation for the support of its annual surplus.

(2) Deduct from the above amount, that is to say, "Total Income," as an annuity properly chargeable to capital, a certain percentage of the appraised value of the physical properties.

From this amount should be deducted rents paid for the lease of property operated and permanent improvements charged directly to income. The remainder would represent the surplus from the gross earnings from the year's operations, and for the purpose of this investigation may be accepted as an annuity which, capitalized at a certain rate of interest, gives the true value of immaterial properties.

To obviate the criticism that both gross and net earnings vary from year to year, it is suggested that in place of a single year's Income Account, the average Income Account of a period of ten years be accepted as the basis of computation. The reason for accepting a period of ten years is that under existing commercial conditions it is likely that the corporation whose property is appraised would, during that period, pass through years of both prosperity and adversity.

It will be observed that the above rule fails to appraise the speculative element in railway property. While this element doubtless affects the price of corporate stocks and corporate bonds, it is not entirely clear that it should influence appraisals for the purpose of taxation. Should, however, the commission desire to compute the present worth of property, as resting upon expectations in the future as well as upon earnings in the past, the pertinency of the above rule would not thereby be impaired. This is true because the speculative value of properties, must, from the nature of the case, be a modification of their value computed upon the basis of their earning capacity.

STREET RAILWAYS.

The scope of the appraisal does not apply to street railways, which are incorporated under special laws. The Citizens' Street Ry. Co., of Detroit, had paid a specific tax (based upon gross earnings) until the present year, when, acting upon recommendations from the State Tax Commission, the City Assessors placed it upon the tax roll, the same as any other property owner. In making the recommendation, the Tax Commission took the stand that the city had no power to enter into contract with any corporation giving them special privileges; but that such privileges should come direct from the Legislature. It also made the recommendation to the Assessors that in arriving at the valuation of the Citizens' Street Ry. Co. they take into consideration the franchise value. This was the first instance in the State where this recommendation has been made. An important result was that the assessment was raised from $1,500,000 to $12,000,000.

The street railway company began mandamus proceedings in the Circuit Court, claiming that the assessment was illegal and also fighting the point of franchise value. The case was heard before the entire bench of the Circuit Court of Wayne County and was decided unanimously in favor of the city. The company then took the case to the Supreme Court, the decision of which has not as yet been handed down, but a favorable decision is confidently expected by the Tax Commission. Upon the decision of the Supreme Court there hangs an important factor in the present railway appraisal; namely, the taxation of franchises.

Suburban electric railways, unless incorporated under the General Railway Act, pay an ad valorem tax in each township. This is in addition to the State and county tax. Such lines are, therefore, outside the scope of the present appraisal. Last year, however, they were appraised to a certain extent by the Tax Commission, and this will be done again this year. The Commission makes recommendations to the supervisors, and if it appears that the latter make the assessment too low, the Commission has power to investigate the matter and, if necessary, to raise the assessment.

RESULTS OBTAINED WITH LARGE EXPERIMENTAL SEPTIC SEWAGE TANKS AND RAPID FILTRATION AT WOONSOCKET, R. I.*

By Geo. A. Carpenter.†

On the sand filters of my own city, which have been in operation for six years, the sludge has amounted to 3.18 cu. yds. per 1,000,000 gallons of sewage treated and has been composted near the plant and afterwards used for filling, or on land, if anyone could be found to take it away. If the septic tank is capable of collecting, decomposing and destroying this sludge in any more satisfactory and economical way, we desire to know it. With the purpose of making a comparison between these two methods, sludge accumulation and disposal on sand filters and in the septic tank, the plant in Pawtucket has been run for the last ten months on the latter principle and the results studied. While it may be as yet a little early to make definite conclusions in all respects a review of the results already recorded may be of interest.

Sewage is received direct from the city sewers into a collecting tank measuring 30 × 100 ft., × 4 ft. deep. This has been used as a septic tank and has been filled to a depth of 3 ft. only, as we were limited to that depth by the grade of the inlet pipe. From this tank it overflows at the end opposite the inlet and from a point about 18 ins. below the surface runs into an adjoining tank of the same dimensions, from which it is drawn out on the beds.

On Jan. 12, 1900, this tank was cleaned out and the next day it was started as a septic tank and run continuously until Nov. 13, 1900, when the flow was again shut off and the contents of the tank examined. The liquid portion of the contents was drawn off and the sludge was carefully measured and was found to amount to 152.17 cu. yds. About 4.69 cu. yds. of this was sand which had been washed into the tank by storms and which had collected in one corner. Deducting this we have 147.48 cu. yds. as the amount of sludge collected from 27,166,000 gallons of sewage, or 5.428 cu. yds. per 1,000,000 gallons. Analysis of this sludge showed that 81.75% of it was moisture, thus leaving 26.915 cu. yds., or 0.99 cu. yds. per 1,000,000 gallons, as the actual mineral and organic matter left in the tank.

The average results of 21 analyses of sewage and 23 analyses of septic effluent have shown that the sewage contained a total residue on evaporation of 101.481 parts per 100,000 and the septic sewage 63.748 parts per 100,000. This is a loss of 37.19% of the mineral and organic matter in the sewage during its passage through the septic tank. This would amount to an accumulation of 1.868 cu. yds. of sludge per 1,000,000 gallons of sewage. The difference between this and the 0.99 cu. yds. per 1,000,000 gallons actually found there shows that the septic tank has in some manner disposed of 0.878 cu. yds. of sludge per 1,000,000 gallons of sewage or 47% of all the sludge which has been deposited in it.

* * * * * * * * *

In the passage through the tank the organic matter, as represented by the albuminoid ammonia, has been reduced 41.5%, or from 1.411 parts per 100,000 to 0.825, and the percentage in solution has been increased from 55.6% to 72.7%.

* * * * * * * * *

At Pawtucket we adopted for experimental purposes the tank which we had; but I am inclined to the opinion that better results could have been obtained with a deeper tank.

Results have shown that there is, with the septic method of treatment, a gradual accumulation of sludge, which serves to reduce the capacity of the tank, and that the sludge must be taken out and disposed of in some way about once a year; that there is no offensive odor arising from the septic tank itself, and that it can be covered or not as deemed best; that the sludge deposited is not particularly offensive to handle, and that men will work in the tank without making any objection as to the nature of the work.

If this sludge is spread upon land it should be plowed in or covered with earth to check the odor which would otherwise arise, although this odor is no different than that given off from farm lands upon which the contents of cesspools and vaults have been spread. There is, however, a perceptible odor around works conducted on this principle that is stronger and more disagreeable than any odor that is ordinarily found about intermittent filtration plants. It comes from the gases liberated from the effluent from the septic tank as it overflows and falls into the collecting tank and also as this effluent is drawn off upon the beds. While this odor is not, I think, noticable at a distance of 500 or 600 ft. from the plant, yet in the immediate vicinity it is very marked and in strong contrast with the absence of any such disagreeable features around sand filtration plants. When run simply as collecting basins these tanks were cleaned with a hose every other day, and it was entirely practicable to walk through them without suffering any annoyance. The sights and odors around the septic tanks are not quite as satisfactory, although I think that there is nothing that can be characterized as a nuisance. It seems to me possible, by covering in the collecting tank and providing a stack for ventilation, that a large amount of the gas may be taken off in this manner.

I think that we have not as yet experimented enough to say whether it is better to let everything go into the septic tank to there putrify and decompose, removing the accumulation once a year, or whether it would be preferable to restrain as much of the solid matter as possible before entrance to the septic tank and to provide for its regular and frequent removal. A large amount of this sludge must be removed in any case and it may be advisable to separate, collect and remove this sludge as early as possible and have done with it, thus maintaining the original capacity of the septic tank and depending upon this action of the tank to break up and turn to solution the finer particles of suspended matter that pass the first process of screening or sedimentation. It seems to me that experiments in this direction are very desirable.

* * * * * * * * *

On the experimental bacteria filters in Pawtucket, composed, one of crushed stone of the size known as chestnut and the other of screened cinders from soft-coal ashes, the effluent from the septic tank has been applied at the rate of 527,000 gallons per acre per day for six days in the week, or 100 gallons per cu. yd. of filtering material, which is, I think, a better method of stating the work of bacterial filters.

On the basis of 365 days to the year this is about ten times the amount of sewage which has been applied to an

*Abstracted from a paper read before the League of American Municipalities at Charleston, S. C., Dec. 12, 1900.
†City Engineer, Pawtucket, R. I.

equal area of the sand beds. The effluent, it is true, has not reached the same state of purification attained by the sand filters, but the average of 13 analyses of the effluent from the cinder filters shows that 74.2% of the albuminoid ammonia has been removed and that the oxygen consumed by the effluent is 81.7% less than that consumed by the original sewage. Nitrification has also been well established, as is shown by the presence of 1.0 part of nitrates in 100,000 in the last effluent analyzed.

A second bacterial filter, constructed to receive the effluent from the first filter, has shown a still further purification.

THE WALKER SMOKELESS FURNACE.

In our issue of Oct. 11 we described a boiler furnace in which the production of smoke was prevented by the introduction of a supply of air over the fuel bed. This air, together with the distilled gases, was compelled to pass through a bed of incandescent coke on its way to the boiler surfaces. We illustrate herewith a furnace in which the gases are not led through the fuel bed, but are only thrown down against it by a deflecting arch. The furnace is placed under the end of the boiler instead of out in front of it, as in the case above referred to.

The construction of the furnace may be understood from Fig. 1. The forward part of the grate F is stationary, and slopes towards the rear of the furnace. Back of it is a dumping grate D. The fresh fuel is fired upon the front part of the grate, the incandescent fuel being pushed back upon the dumping grate.

Air is admitted through all parts of the grate and also from the conduit H. The air for this conduit may be brought up from the ashpit through passages in the side walls, and will then serve to preserve the latter from the destructive effects of heat. This air mingles with the smoke rising from the grate and the mixture is thrown down by a reverberatory action against the incandescent fuel bed at the rear of the furnace. This insures complete and smokeless combustion if properly fired.

The same principle may be applied to various other kinds of furnaces besides boiler furnaces. A puddling furnace is shown in Fig. 2. The supply of air over the fire should preferably be heated and it may be drawn from a regenerator or other device. Two furnaces of this type are in use in an eye-bar upsetting plant at the Carnegie Works at Pittsburg, Pa., and they are said to show improved economy of coal over the furnaces which they replaced.

Efficiency tests have been made of a number of boiler plants equipped with the furnace above described, and the results are summarized below:

Results of Tests of Walker Furnace.

Tested at.....	Rockland Print Wks.	Keystone Brewery.	Hollingsworth&Vose.
By	Walker.	Hyde.	Hyde.
Time	12 hours.	10 hours.	10.23 hours.
Type of boiler.....	Return tube.	Heine.	Return tube.
Dimensions	72" x 18'	.....	.....
How fired	Hand.	Hand.	Hand.
Heating surface ..	1,860 sq.ft.	.....	.....
Htg surf. per HP..	11.4	.....	.....
Grate surface	43 sq. ft.	42 sq. ft.	30 sq. ft.
Fuel	S. c. slack.	Run of mine.	Pocahontas.
Fuel per sq.ft. grate per hour	13 lbs.	22.8 lbs.	14.5 lbs.
Water evap. pr hr.	4,386 lbs.	8,538 lbs.	4,010 lbs.
Evaporation per lb. combustible* ..	11.16 lbs.	10.68 lbs.	11.62 lbs.
Steam pressure ...	53 lbs.	120 lbs.	128 lbs.
Temp. of feed....	106°	170°	65°
Draft	0.5-in.	0.6-in.	.....
HP. developed	146	268	140
Rated, HP.	124	250	.....
Temp. escapg gas.	421°	583°	423°

*From and at 212°.

For the material from which this article has been prepared we are indebted to the inventor and patentee of the furnaces described, Mr. Robert L. Walker, Park Row Bldg., New York city.

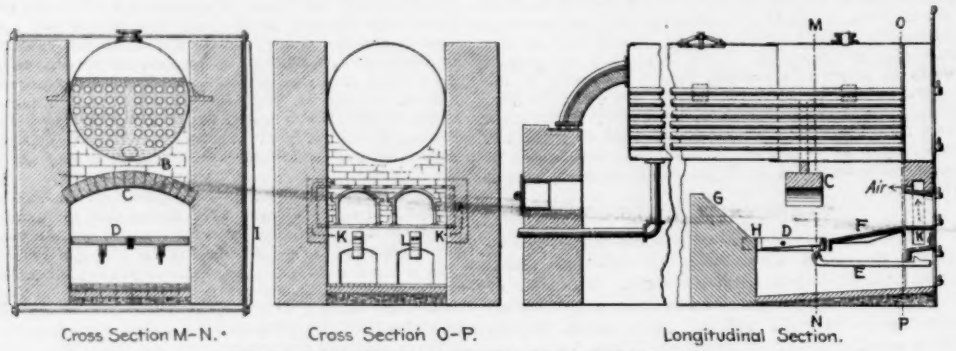

FIG. 1.—WALKER SMOKELESS BOILER FURNACE.

B. Wall above arch.
C. Firebrick arch.
D. Rocking or dumping grate.
E. Connecting rod of grate.
F. Common grate.
G. Bridge wall.
H. Sill level with grate.
I. Brick stay.
K. Air conduit.
L. Angle iron.

ANNUAL CONVENTION OF THE AMERICAN INSTITUTE OF ARCHITECTS; WASHINGTON, D. C.

The thirty-fourth annual convention of the Institute was held at the Arlington Hotel, Washington, D. C., Dec. 12 to 15, 1900. The convention was opened with an address of welcome by Mr. H. B. F. Macfarland, President of the Commissioners of the District of Columbia. Mr. Robert S. Peabody, of Boston, President of the Institute, delivered an address, and reports were received from the Board of Directors and the Chapters of the Association, and from a number of special committees on matters connected with the profession. These showed the work of the Institute to be in a very healthy condition. The report of the treasurer showed the receipts during the last year to be $6,038, and the expenses $5,372, leaving a balance of $665. The present officers were re-elected: President, Robert S. Peabody, Boston, Mass.; First Vice-President, W. S. Eames, St. Louis, Mo.; Second Vice-President, Frank Miles Day, Philadelphia, Pa.; Secretary and Treasurer, Glenn Brown, Washington, D. C. Directors to serve three years: John Carrere, New York city; James McLaughlin, Cincinnati, O.; R. C. Sturgis, Boston, Mass. The next meeting will be held at Buffalo, N. Y.

Much of the time of the convention was given to the consideration of the improvement and grouping of the public buildings in Washington; four papers, illustrated by lantern slides, being presented on that subject, and the following resolution passed:

Resolved, That the American Institute of Architects advocates and urges upon Congress the importance of procuring, through a commission created for this end, the best obtainable general design for the purpose aforesaid.

The convention also voted that a special committee of the Institute, consisting of seven members, should be appointed by the President to prepare and submit to the Board of Directors a draft of a bill providing for such a commission, and that the Board of Directors have power to alter and amend such measure and to instruct the special committee to present the same to Congress on behalf of the Institute. The President of the Institute appointed as the committee the following gentlemen: William A. Boring, of New York; G. F. Shepley, of Boston; Frank Miles Day, of Philadelphia; W. S. Eames, of St. Louis; Edward B. Green, of Buffalo; Joseph C. Hornblower, of Washington, and Bruce Price, of New York.

A resolution was also passed that a commission, largely formed of architects of recognized ability, should be appointed without delay either to appoint an architect to devise the best possible scheme for the alteration and enlargement of the White House, or to select an architect for the purpose by such limited competition as has been successfully used for other recent government works. Messrs. W. S. Eames, of St. Louis; George B. Post, of New York, and R. W. Gibson, of New York, were appointed a committee to bring the above resolution to the attention of the proper authorities and to have general charge of the matter.

The Committee on Conference with the Architectural League of America on Competition Codes, Mr. R. Clipston Sturgis, of Boston, Chairman, presented the following code, which was adopted:

It is recommended that when possible an architect should be employed without competition. When competition is necessary, the American Institute of Architects recommend the following as a code for its conduct: A competition as a means for the selection of an architect may properly assume one of the following forms: (A) Limited to a certain number of architects, each of whom is invited to take part. (B) Open to all who desire to enter or to all of a certain class. (C) Mixed, certain architects being invited but others being at liberty to take part. In all competitions the first prize should be the award of the commission to design the building and superintend its construction, and the programme should definitely state that the successful competitor will be so retained, and that he will be paid for his services at the rates established by the American Institute of Architects. In certain cases, however, this procedure may not be legal, then the course to be pursued as to the successful competitor should be clearly stated. To provide for the contingency of delay or of the discontinuance of the work, the programme should provide for a substantial payment to the successful competitor on the award of the competition, such payment to be regarded as on account of the final commissions. Payments to unsuccessful competitors should be as follows: In limited competitions each should be paid a fixed amount; in open competitions prizes fixed in number and amount should be provided; in mixed competitions the two classes of competitors should be paid in the manner above described.

It is highly desirable, in the interests of both owner and competitors, that a professional adviser should assist in the preparation of the programme and that the professional adviser or a competent jury, consisting at least in part of experts, should assist in making the awards. The professional adviser or jury may have full power to make the award, or they may select a number of designs and, placing them in the order of merit, leave the final choice to the owner or his representatives. Where possible, the adviser or the jury should make a positive report in favor of one design, and recommend the employment of its author as architect for the building.

The Special Committee on Conference with Heating and Ventilating Engineers made a report in which it called attention to the fact that in the design, construction and equipment of modern buildings the problem of electrical, sanitary and mechanical engineering, of heating and ventilation, of structural work and foundations, are much more complicated and their solution much more expensive than was the case when the present schedule of charges of the Institute was first adopted, and that this development had in many cases rendered necessary the employment of experts, either permanently on the staff of the architect, or by engagement for a specific work. In view of this fact it was recommended that the schedule of charges of the Institute be so amended that the minimum charge for professional services in connection with electrical, mechanical and sanitary engineering, heating and ventilating shall be 10% on the cost of these portions of the work, the architect to select or approve any experts required and to assume all expense for their services, whether rendered by members of his personal staff or engaged for a specific work. The report of the committee was adopted, and the Board of Directors of the Institute authorized to make the necessary changes in the schedule of fees.

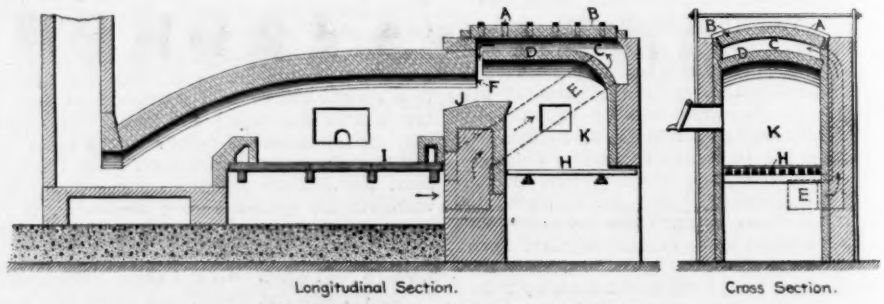

FIG. 2.—WALKER PUDDLING FURNACE.

A. Iron clamp.
B. Arch over air-space.
C. Air duct.
D. Arch or roof of firepot.
E. Air duct through side walls.
F. Deflector.
H. Grate bars.
I. Hearth.
J. Bridge wall.
K. Firepot.

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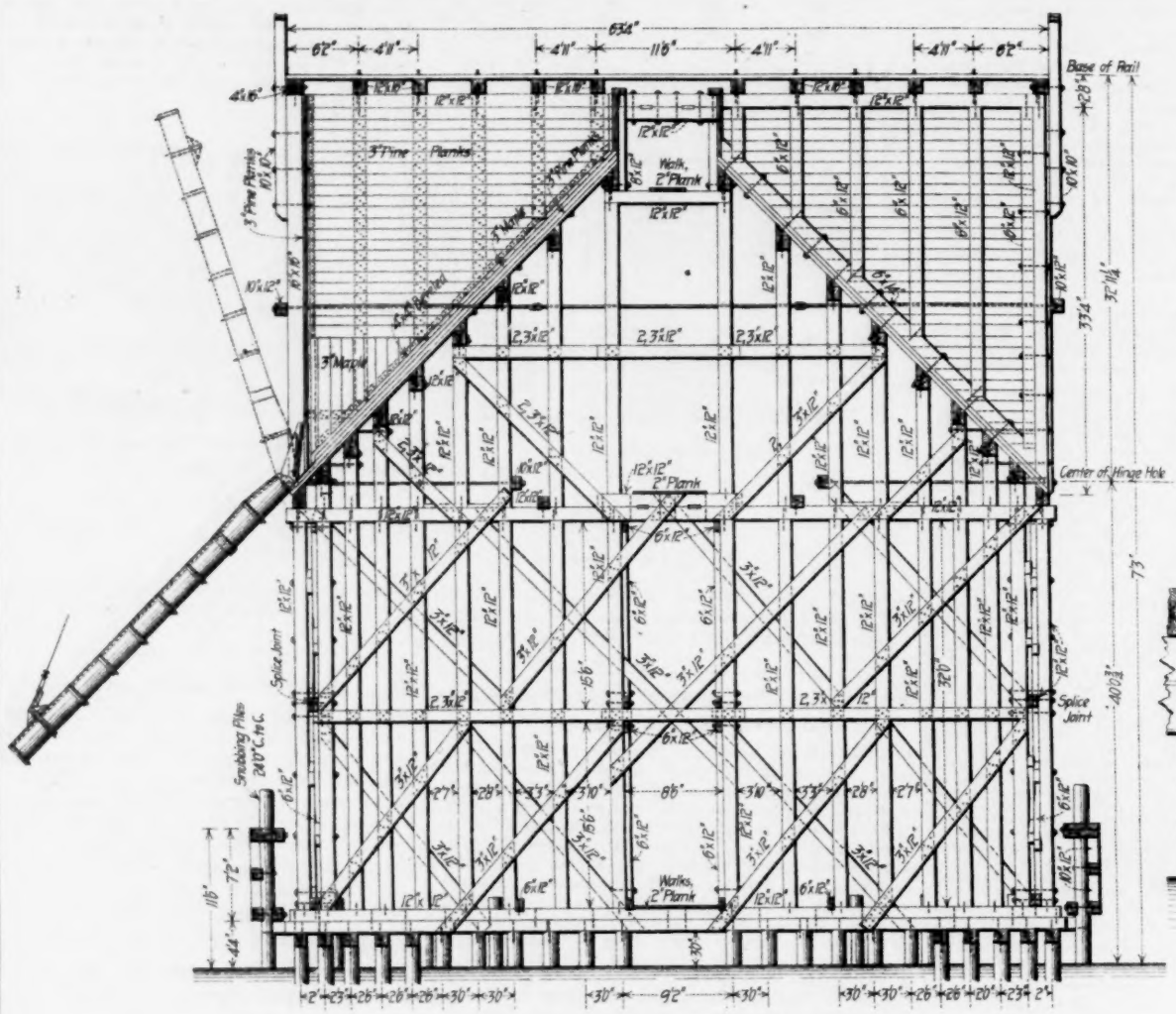


FIG. 1. TRANSVERSE SECTION.

FIG. 2. DETAILS OF FENDER.

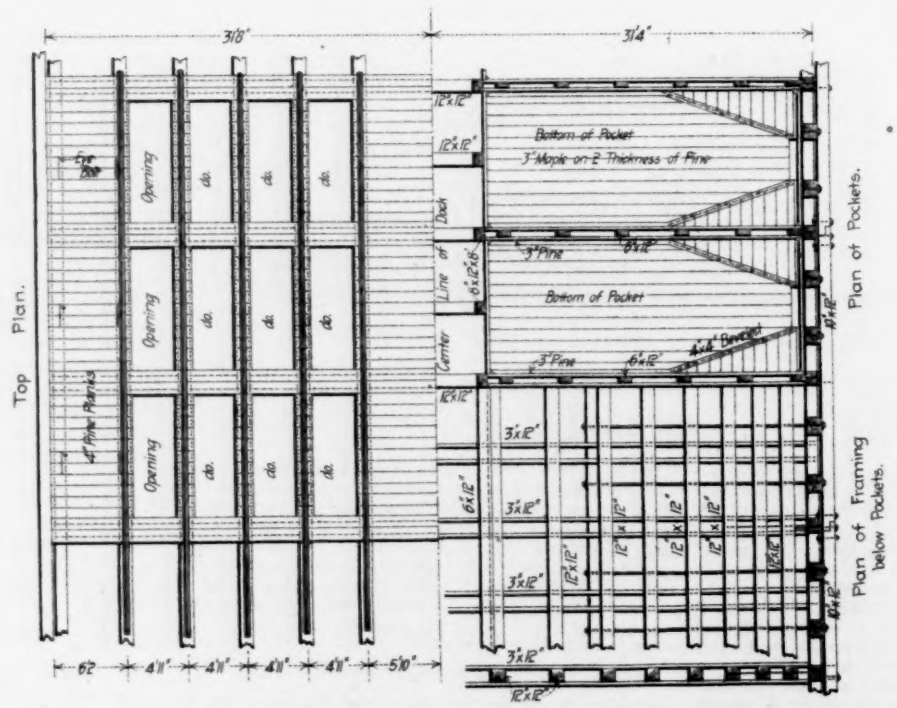


FIG. 5. PART PLAN SHOWING POCKETS, POCKET FRAMING AND TRACK CONSTRUCTION.

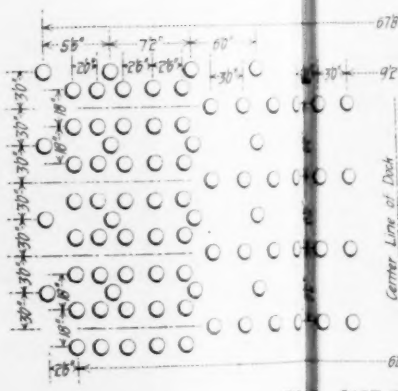


FIG. 3. PART P

FIG. 6. SID

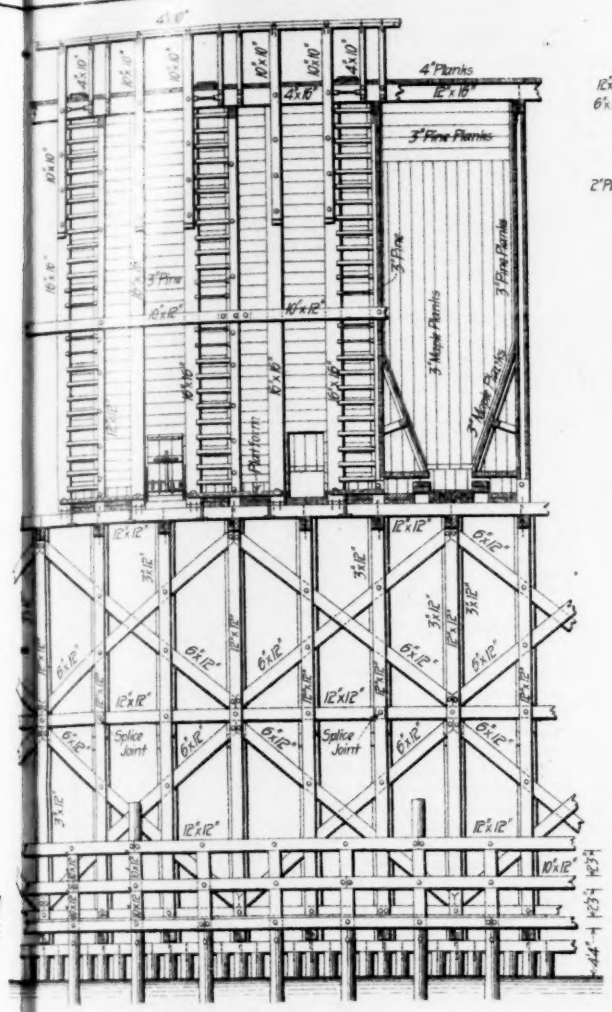


FIG. 6. SIDE ELEVATION SHOWING SECTION OF POCKET.

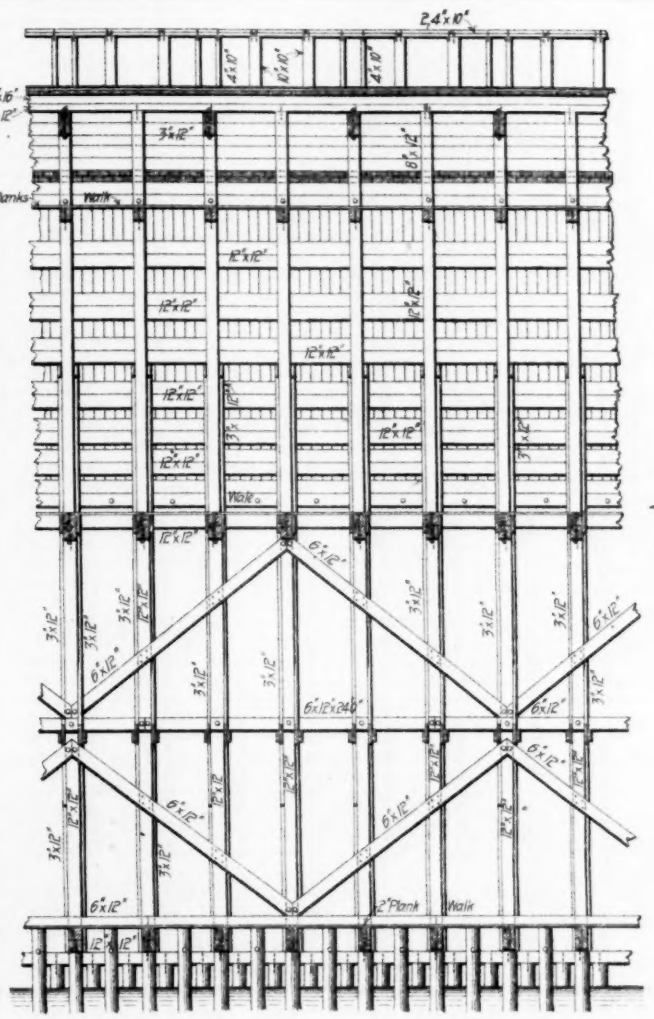
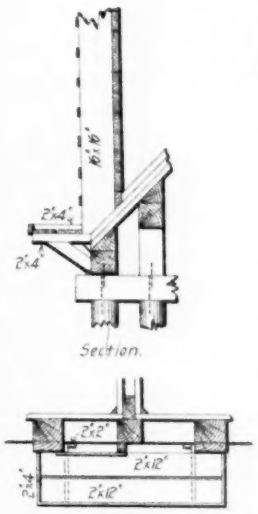


FIG. 7. LONGITUDINAL SECTION.



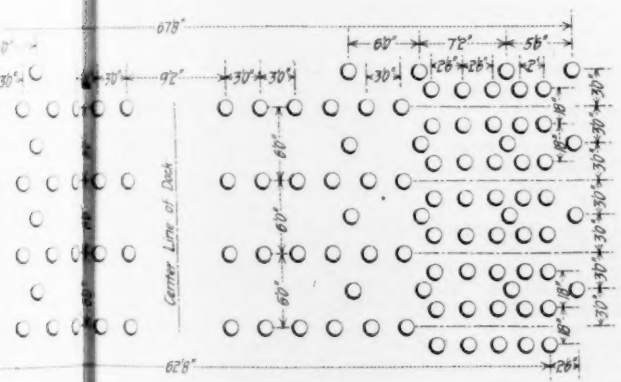


FIG. 3. PART PLAN OF PILING.

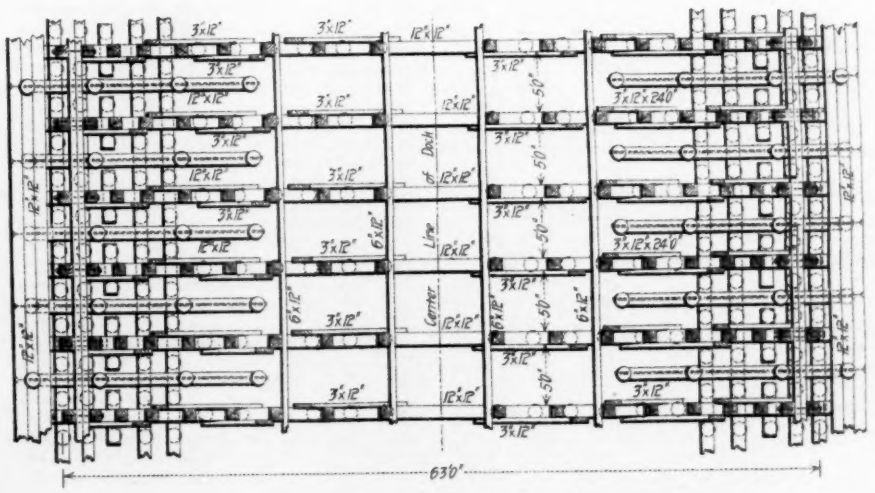


FIG. 4. SECTIONAL PLAN SHOWING PLATFORM TIMBERING.

THE 40,000 TON ORE DOCK OF THE GREAT NORTHERN RY., WEST SUPERIOR, WIS.

John F. Stevens, M. Am. Soc. C. E., Chief Engineer.

CHAS. HART, LITH., 26 VESEY ST., N. Y.